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RELAÇÕES ENTRE OS ATRIBUTOS DAS TRANSAÇÕES E A COMPLEXIDADE DA TOMADA DE DECISÃO NO CONTEXTO DA ARMAZENAGEM DE SOJA

RELATIONSHIPS BETWEEN TRANSACTION ATTRIBUTES AND DECISION-MAKING COMPLEXITY IN THE CONTEXT OF SOYBEAN WAREHOUSING

[TRADUÇÃO INGLESA]

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RELATIONSHIP BETWEEN THE TRANSACTION ATTRIBUTES AND THE COMPLEXITY OF DECISION-MAKING IN THE CONTEXT OF SOY STORAGE

Dissertation presented to the Post-Graduate Program in Business Administration (PPGAdm) professional master's degree of: State University of Western Paraná, as partial requirement for obtaining the Master's Degree in business administration.
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Dissertação apresentada ao Programa de Pós-Graduação em Administração em cumprimento parcial aos requisitos para obtenção do título de Mestra em Administração, área de concentração Competitividade e Sustentabilidade, linha de pesquisa Estratégia e Competitividade, APROVADO(A) pela seguinte banca examinadora:

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RESUMO

Este estudo tem como objetivo investigar as relações entre os custos de transação, através da análise dos atributos, frequência, incerteza e especificidade de ativos e também a tomada de decisão dentro da cadeia de armazenagem de soja. Foram analisados os principais custos de transação existentes e como diferentes combinações e intensidade de ocorrência dos atributos se relacionam com a complexidade das decisões a serem tomadas. Para tanto, a pesquisa abordou os conceitos da Teoria da Economia dos Custos de Transação e da Tomada de Decisão, aplicando-os ao contexto do agronegócio e do sistema agroindustrial. Para isso, este trabalho teve abordagem qualitativa, utilizando-se da análise documental e com dados analisados por meio da Análise do Conteúdo. Verificou-se que custos de transação impactam de forma direta a cadeia, e que a existência de oportunismo e especificidades torna maior a complexidade da tomada de decisão por parte dos agentes.

Palavras-chave: Estratégia; Tomada de Decisão; Custos de Transação; Armazenagem de grãos.

ABSTRACT

This study aims to address the relationship between transaction costs, through the analysis of attributes, frequency, uncertainty and specificity of assets, and decision making within the soy storage chain. Were analized, the mains transactions costs and how different combinatios and intensity of occurrence of the attributes are related to the complexity of the decisions to be made. To this end, the research addressed the concepts of Transaction Cost Economics Theory, Decision Making applying them to the context of agribusiness and the agro-industrial system. For this, this work had a qualitative approach using document analysis and with data analyzed through Content Analysis. It was found that transaction costs have a direct impact on the chain, and that the existence of opportunism and specificities, makes the complexity of decision making on the part of the agents greater.

Keywords: Strategy; Decision making; Transaction Costs; Grain storage.

DEDICATORY

To my parents, who have always given me support, encouragement, affection, and love, and the certainty that regardless of the height and direction of my flight, the nest will always remain in the same place.

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To God.

To my parents, for being my greatest source of example, inspiration, and mirror of conduct and character.

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SUMMARY

1 INTRODUCTION

Soybean storage, the main Brazilian commodity, plays a fundamental role in the proper functioning of the agribusiness production chain. However, the lack of structures to store the entire grain production in Brazil, and the transaction costs inherent to this context, directly impact the rural producer and, consequently, his remuneration and autonomy in decision making. The agricultural environment is permeated by uncertainties, seasonality, and several other variables that make the decision-making process even more complex.

To analyze the transaction costs and complexity of decisions, central constructs in this study, this work had as its theoretical basis the New Institutional Economics (NIE), based on the studies of Douglas North (1991) and Oliver Williamson (1985), who had Coase's work (1937), The Nature of the firm, as a precursor, based on the idea of a new institutionalism, which admits that there are costs associated with transactions. Theoretical support was also provided with respect to decision making, based on the works of Simon (1982).

Based on NIE, Transaction Cost Economics (TCE) suggests that exchanges occur in an environment permeated by problems, uncertainties, and complexity, without the control of the individual, where the context is dependent on a social framework that supports the relations (Carvalho, 2004).

Williamson (1985) presents the TCE from some behavioral assumptions, which highlight that companies are immersed in an environment permeated by bounded rationality and opportunistic behavior. Bounded rationality means that the individual has limits in his cognitive capacity to process all available information. By opportunism, one assumes the idea that individuals are self-interested, and that they may, under certain circumstances, deceive and act based on their own interests (Azevedo, 2000).

Such assumptions, combined with an environment permeated by unpredictability, are associated with transaction costs. The degree of contextual factors, such as information quality, project uncertainty, trust, organizational efficiency, and change requests can also be the causes of transaction costs (Haaskjold, Andersen, Lædre & Aarseth, 2019). The relevance and size of such costs is dependent on some attributes of the transactions, which are uncertainty in the environment, asset specificity, and transaction frequency (Mendes, 2005).

Martins, Rebechi, Prati, and Conte (2005) advocate the idea that having knowledge about costs, whether direct or indirect, of any economic activity tends to provide possibilities

of obtaining competitive advantages. From this perspective, cost management and analysis must be inserted as an input in strategic business decisions.

Moving on to the decision-making analysis, Simon (1995) leads us to understand that decision-making is involved in many areas and human activities, such as political science, economics, organizational theory, arts, philosophy, psychology, and others. In other words, to holistically understand human decision making, several activities must be involved in this process.

Simon (1982) further describes decision making as of two classifications: programmed and non-programmed decisions. Situations that occur on a daily basis and with greater frequency, in which the decision maker is already familiar, allow decision making to be simpler or programmed. These usually occur in an environment of low uncertainty. The unscheduled ones occur when faced with a new, unstructured, or unforeseen situation. Therefore, there is no pre-fixed solution to deal with the scenario, due to its diverse structure and the multiple variables that present themselves.

Oliveira (2007) states that when the decision process takes place under conditions of certainty, each possible alternative choice leads to a single consequence. However, when decisions arise in risk environments, there are several consequences for each possible choice, and the probability of occurrence of each consequence is not known. When these probabilities cannot be measured, decisions occur under conditions of uncertainty.

Complex environments have countless variables and consist of networks formed by active, autonomous agents whose behavior is determined by a set of rules and by information about their performance and environment conditions (Agostinho, 2003). Rathmann (2007) rectifies this idea by pointing out that decision making is more common under conditions of variation in the degrees of risk and uncertainty. Such aspects make explicit the complexity that decision making involves, and reinforces the need for detailing, as well as the understanding of other influencing factors in this process (Sampaio & Lima, 2015).

According to Vale and Lopes (2010), companies are inserted in an environment of pressure to make decisions and can often invest in an intermediate alternative. This choice brings with it factors associated with the characteristics and conditions of the transaction to be carried out and that will have impacts on transaction costs (Bronzo & Honório, 2005). From this point on, the NIE and its characteristics provide paths that help to understand the factors that influence agents' decision-making and rationality, whether at the individual level or in the environment in which they operate.

Taking this idea to the agricultural environment, the rural producer in situations of pressure to negotiate and store his crop may close deals with companies often without considering and analyzing the weight of the transaction costs involved in this decision. Thus, the environment is complex and permeated with doubts as an intensifier of bounded rationality, opportunism, uncertainties, and asymmetry of information. It is quite coherent to insert the agricultural production chains into this context, since the climatic and economic seasonality, as well as dependence on nature, and a network with several relationships among all the agents of the chain, enhance the complexity of the environment and the decisions to be made.

When agricultural products are delivered to the industry, several direct and indirect costs arise, due to the transactions of harvest, collection, processing, and storage of the grain (Abebe, Bijman, Kemp, Omta, & Tsegaye, 2013). In other words, the intense network of relationships in agribusiness has transaction costs that oscillate according to the variation of the intensity of the attributes of uncertainty as to the results, of assets specificity, and of the frequency of transactions. Because the agricultural environment is composed of several variables, it is not always possible to predict which are the best actions to be taken, that is, the more complex the environment, the more complex the decision-making process (Dutra & Rathmann, 2008).

Given the above, the decision-making process in productive agro-industrial chains is permeated by uncertainties, asymmetries, incomplete information, limited resources and rationality, multiplicity of objectives, and conflicts of interest. These circumstances directly affect the profitability and assertiveness in the choices made by the rural producer, and indirectly increases obstacles in the functioning of the chain itself, since the complexity of the decision process can compromise the supply of products during the production process.

The process of harvest storage is an example of a relationship between rural producers and the industry. As such, it carries several transaction costs. It has risks, uncertainties, and specificities inherent to its operational structure. For Martins *et al*. (2005), the consequences of this type of complex relationship follow a cycle: with low returns in the storage and sale of the harvest, the industry cannot modernize, and the service provided may lose quality. Additionally, there is the build-up of stocks above acceptable levels, which leads to cost aggregation in the economy, and the concentration of agricultural supply in a few months of the year puts pressure on agricultural prices.

Thus, for the decision to be as close as possible to the ideal, it is necessary to consider exogenous characteristics to the agricultural chain, such as asset specificity and frequency and the level of information that permeates this environment full of multiple variables (Dutra & Rathmann, 2008). Given this framework, it is important that the players know and recognize

business opportunities that may be potentially profitable compared to others that have greater negative influences of the exogenous characteristics mentioned above.

1.1 RESEARCH PROBLEM

Agroindustrial systems are formed by sets of transactions, which are guided by different degrees of interaction. In these sets, there are elements that have an impersonal relationship of trust (Farina, 1997) or a relationship of conflict and cooperation (Zylbersztajn, 2005). Such relations occur through contracts, and have costs, which Coase (1937) calls transaction costs.

According to Dutra and Rathmann (2008), the management of commodity-based production chains carries in its decision process, situations that are quite specific, with a large number of relationships along its course, and variables to be analyzed. Agribusiness should be understood in its various branches as a nexus of contracts (Mendes *et al.*, 2009). These occur from the producer within his farm, through the industry, commerce, to the final consumer. Considering the dependence of such agents and their need for the continuity of transactions within this context, such situation reinforces the theory of transaction costs (Sheldon, Caríssimo, & Floris, 2020).

Added to this, the agricultural activity carries with it a high degree of uncertainty due, for example, to the seasonality of production and prices, the possibility of unfavorable weather conditions, and issues related to the destination of production such as storage, sale, and consumption (Buainaim & Souza Filho, 2001). The amplitude and complexity of the aspects involved in the decisions in productive agro-industrial chains demand from their integrating agents a systemic vision of the chain due to the inter-relations that will exist between the variables in this environment (Machado, Coronel, Pinto, & Lago, 2015).

These characteristics emphasize the existence of complexity and are not always predictable. In view of this, the context and the decision-making process of the players involved in agro-industrial production chains would be permeated by uncertainties, asymmetries, incomplete information, limited resources and rationality, multiplicity of objectives, and conflicts of interest (Dutra & Rathmann, 2008).

In this sense, as pointed out by Schlabitz (2008), the theory of transaction costs is crucial to the decision-making process, since institutions are permeable, both internally and externally, by the exchange relations between economic agents, whether individuals or firms. In an environment that requires a strong degree of specialization and a rational division of labor in

which the transaction is the focal point, transaction reduction encourages cooperation and mitigates opportunism, increasing production mechanisms in an efficient manner.

Due to the characteristics that involve the decision making process within productive chains, the analysis of decision making must involve the study of variables that are relevant and related to the process. In this case, the variables that impact the transaction costs in the grain storage process will be analyzed, which is today one of the major logistical bottlenecks of the agricultural crop.

Despite the agribusiness presenting very positive trade balances over the last years, the lack or inadequacy of logistic infrastructure reduces the competitiveness of the Brazilian product in the international market. It is also known that storage can be used as a commercialization strategy by Brazilian producers and exporters, in order to obtain a higher income from the sale of their production (Rocha, João, & Caixeta-Filho, 2017).

Corroborating this view, Barbosa, Alessio, Velho, Costa Filho, & Costa (2020) point out that Brazil has been consolidating worldwide as a major grain producer. Despite the productive advances, the losses in Brazilian agriculture during the processes of harvest, transport, and storage cause financial losses, reducing the competitive potential of agribusiness and, consequently, impacting the soybean production chain, both economically and in terms of waste and increased production costs.

Some identified studies deal with transaction costs in agribusiness chains. Ojima and Comitre (2008) researched the existence of transaction costs in the railway environment by analyzing the movement of soybean, sugar, and alcohol commodities from the perspective of transaction attributes. De Silva and Ratnadiwakara (2008) analyzed the effect of information and communication technologies in reducing transaction costs for small rural producers in Sri Lanka, making explicit the need for information available to rural producers throughout the production chain.

Dutra (2008) conducted a study in which he sought to raise the factors that may influence the decision-making process for the implementation of a soy warehouse in a rural property and found that the relevant variable was the level of information that the producer had, so that he identified that the limits of decision making, related to the levels of information of the decision maker, ranged between certainty, risk, and uncertainty.

Silva and Brito (2013) evaluated the impact of uncertainty, bounded rationality, and asset specificity on opportunistic behavior in supply chains. Weseen, Hobbs, and Kerr (2014) designed a study to assess the extent to which uncertainty, asset specificity, and transaction frequency create incentives for opportunistic behavior in the ethanol sector in western Canada.

Palhano (2015) studied which relationship between rural producers, agents, and industries in the soybean procurement process had the lowest transaction cost, whether it was through the market, hybrid form, or vertical integration.

Gërdoçi, Skreli, Panariti, and Repaj (2016) investigated, together with 170 Albanian farmers who grow aromatic medicinal plants, the role of uncertainty behavior in determining the impact of relational ties between farmers and their purchasers. Sheldon *et al.* (2020) analyzed the outcomes of the truck drivers' strike that occurred in Brazil in 2018 through the NIE theoretical framework, specifically addressing the theoretical assumptions of Transaction Cost Theory.

However even with the advancement of research in this field, the field is still fertile for research that relates transaction costs to decision making, since this field is not yet fully understood. This importance is confirmed when analyzing North's (2005) teaching, in which he makes it clear that decisions would be easily rational if all choices were simple, frequent, and with quick and effective returns. However, when prices, costs, and negotiations become dependent on other agents, the complexity of the situation increases.

In the practical field, understanding the effect that these costs can cause in the producer's choice process opens up the possibility of creating competitive advantages through actions, measures, and alternatives that reduce them. According to Ballou (2011), the cost of storage can range from 12% to 40% of logistics expenses. Thus, evaluating the existence and impact of transaction costs in this environment presents itself as a strategic element to promote gains in competitiveness, in order to guide the choices made by the decision maker.

Thus, the research question that guides this study is presented below.

1.1.1 Research Question

What are the relationships between transaction attributes (frequency, asset specificity, and uncertainty) on the complexity of decisions to be made in the grain storage context?

1.2 OBJECTIVES

To answer this question, the following objectives were elaborated:

1.2.1 General

Analyze the relationships between transaction attributes (frequency, asset specificity, and uncertainty) on the complexity of decisions to be made in the grain storage context.

1.2.2 Specific

a) Identify the main transaction costs involved in soybean storage structures by analyzing the asset specificity, frequency, and uncertainty.
b) Analyze the impacts of uncertainty, asset specificity, and frequency (high, medium, and low) on the level of complexity of the decisions to be made.
c) Elaborate an analytical structure to relate the attributes of the transactions and the complexity of the decision making.

1.3 JUSTIFICATION AND CONTRIBUTION OF THE TECHNICAL PRODUCTION

Knowing the costs involved in any economic activity tends to provide a number of possibilities for creating competitive advantages. Whether these costs are directly measurable as production costs, or indirectly as transaction costs, they also serve as an important tool to support decision making in order to maximize results. They also serve as an important tool to support decision making in order to maximize results.

The agricultural activity carries with it a high degree of uncertainty arising from the seasonality of production and prices and the possibility of unfavorable weather conditions, in addition to issues regarding the destination of the production, such as storage and sale. The inter-relationships that involve the process of delivering production to the processing industry lead to high transaction costs.

Although agribusiness is fundamentally important to the Brazilian economy, there are few studies related to the understanding of transaction costs in its chains and even fewer related to the impact they have on decision making (Dutra, Machado, & Rathmann, 2008). In this context, this research is justified in two main points. First, in the analytical and theoretical scope, since there are relatively few studies focused on studying transaction costs and their impacts on the decision-making process and also aimed at grain storage. In practice, it may create precedents for rural producers to consider different forms of storing their production

aiming at minimizing transaction costs and increasing the economic return of their business.

1.4 DISSERTATION STRUCTURE

This paper is structured in five main parts. The first includes the Introduction, with an initial presentation of the themes addressed in the research, the objectives, general and specific, the research question, the problem, and the justification.

Subsequently, a theoretical reference that addresses a contextualization of agribusiness in Brazil and its Agroindustrial Systems (SAG) is presented. It also presents the main concepts of the New Institutional Economics, especially Transaction Cost Economics with its assumptions and attributes. Along with this, a brief review of the main ideas concerning decision making is proposed. And finally, still within the theory, the situation of warehousing in Brazil is addressed and the experiences of similar works found in Brazil and in the world. From this referential, and based on the theoretical support found therein, four propositions were created, which will be confirmed or not, along the analysis of the results found.

The next section explores the materials and methods in which the research design is presented, as well as the procedures of collection and analysis of results adopted for the study. To close the paper, the fifth main structure presents the analysis and interpretation of the results and, finally, the research conclusions, which summarize the main analyses of the results, as well as the limitations of the research, contributions, and suggestions for future work.

In Chart 1, there is a tying matrix that presents the reasoning followed for the data analysis and the achievement of the specific objectives. It also shows the main variables analyzed for each objective.

	SPECIFIC OBJECTIVE	**DEPENDENT VARIABLE**	**ANALYSIS VARIABLES**
1	Identify the main transaction costs involved in grain storage structures by analyzing asset specificity, frequency, and uncertainty.	Transaction Attributes	Freight Cost/Price Storage Fees Soybean Price
2	Analyze the impacts of uncertainty, specificity, and asset frequency (high, medium, and low), on the level of complexity of the decisions to be made.	Decision Making Complexity and Transaction Attributes	Combination of transaction attributes and governance structures

3	Develop an analytical framework to relate transaction attributes and decision-making complexity	Decision Making Complexity and Transaction Attributes	Combination of transaction attributes and governance structures

Chart 1. Research Tying Matrix.
Source: Prepared by the author (2021).

2 THEORETICAL AND PRACTICAL REFERENCES

The two analytical constructs of this study, which are decision making and transaction attributes, allow for a relationship between them. The Transaction Cost Economics revolutionized the understanding of strategy decisions. This allowed adding to this area the questioning of economic aspects and also of how the attributes of a transaction can affect the decision, especially when the existence of bounded rationality and the possibility of opportunism among partners in an exchange and in market transactions is made explicit (Mainville & Peterson, 2006).

To analyze the decision making process in the soybean agro-industrial chain, focusing on the grain storage stage, which is the object of this research, endogenous and exogenous characteristics must be taken into account. Some examples are the specificity and frequency of the asset to be traded, in addition to the level of information and the type of decision to be made in the decision-making process. The diversity of variables to be observed for this process, which precedes decision-making, demonstrates that it has a high degree of complexity, which makes it difficult to carry out (Dutra & Rathmann, 2008).

The theoretical review of this paper was divided into four sections. Section 2.1 presents a review of the New Institutional Economics (NIE). Section 2.2 discusses transaction costs, and their attributes are presented in subtopics. Section 2.3 will address the main concepts about Decision Making. The objects of study will be presented in sections 2.4, with an approach to agribusiness and agroindustrial chains, section 2.5, with a contextualization of grain storage in Brazil, and section 2.6, which will discuss the soybean chain.

2.1 NEW INSTITUTIONAL ECONOMICS (NIE)

The first idea for the concept of New Institutional Economics emerged through the seminal work of Coase, in 1937. After Coase, authors such as Oliver Williamson (1985) and Douglass North (1991) structured what today is called the NIE in a more convincing way. In his seminal article, The Nature of the Firm, Coase (1937) investigates the factors that justify the reasons why firms exist, and that this existence cannot only be justified by the occurrence of price mechanisms guiding their transactions. Therefore, the firm exists to minimize transaction costs, since according to his vision, the price mechanism cannot function as a perfect regulator of transactions and production.

Grounded on this approach, as of an article by Oliver Williamson (1975), the New Institutional Economics (NIE), which is one of the streams belonging to Institutional Economics, emerged as a complement to the old Neoclassical Economics. According to Langlois (1982), within the NIE, the unlimited rationality defended by the Neoclassical Economics is now approached as limited. The decision process becomes the focus of analysis, and the cognitive aspects of the agents are addressed in the decision-making process. Furthermore, the price is no longer considered the sole responsible for the coordination process of the economy. And cooperation and coordination are attributed to the origins of institutions.

The NIE is composed of three schools of thought. One of them, called Transaction Cost Economics, studies the forms of organization focused on the firm and has, as its main researchers, Coase (1937) and Williamson (1985); the other focuses on institutional changes and economic history, as advocated by North and Matthews; and yet another current that aims at situations of equilibrium in the interactions, which finds support in Game Theory and authors such as Schelling (1960), Schotter (1981), and Shubik (1971) (Théret, 2003).

According to North (1991), it is the institutional environment that holds the rules of the game, which structure social, economic, and political interaction, whose main role is to restrict human actions and create order. For Coase (1937), firms arise when certain agents within an interacting system provide production services, and thereby acquire the right to coordinate their use, as well as to determine how these services are allocated within the network.

The advantage of this form of organization is the possibility of reducing costs linked to the use of price mechanisms, or market exchanges. Such costs are called "transaction costs". Thus, it is up to individuals to minimize such costs through the choice of the mechanism for allocating resources, which are the institutions, which in general encompass the firms, the market, and the State. The better the coordination among the components of the system, the lower the costs of each one of them will be (Azevedo, 2000).

The NIE has as its main foundation the approach of the role of institutions in two analytical levels (Azevedo, 2000). One of them is the institutional environment, which contemplates the macro-institutions, whose responsibility is to establish the bases for interactions between human beings, structured by North (1991). The other level deals with micro-institutions, which regulate specific transactions. It is within the latter that the Transaction Cost Economics is inserted, structured by Williamson (1985).

2.2 TRANSACTION COST ECONOMICS (TCE)

Coase (1937) observed that the functioning of the economic system generated costs through its transactions. Then, he defined that there were two forms of transaction costs: information collection costs and the costs of negotiating and establishing a contract. Through a more general view, Furubotn and Richter (1994) define transaction cost (TC) as costs necessary to put the social and economic mechanism into operation. This means that they are costs not directly linked to production, but that arise as the agents relate to each other and coordination problems occur (Farina, 1997).

As defined by Williamson (1981, pg. 552), a transaction occurs when a good or service is transferred between agents. According to Azevedo (2000), transaction costs arise when companies encounter coordination problems when relating to each other, thus, this would be the cost of incurring in markets. To try to minimize transaction costs, firms and agents must choose the best organizational and relationship arrangement. Shelanski and Klein (1995) wrote that TCE studies how partners protect themselves from the risks associated with exchange relationships in a transaction.

Based on the foundations of Williamson (1989), the TCE is based on two hypotheses or behavioral assumptions: bounded rationality and opportunism. This means that the former is defined from the view that the agents of the process do not possess complete information about a given situation-problem, and the opportunistic behavior manifests itself by the strategic manipulation of information or falsification of intentions by the agents (Williamson, 1975).

From these assumptions, dimensions for measuring transaction costs arise, that is, they are defined according to the frequency with which they occur, the degree and type of uncertainty to which they are subject, and the asset specificity condition (Williamson, 1996). These three parameters are called transaction attributes, and their combinations among themselves will result in different forms of governance and contract structures, aiming at minimizing costs or even mitigating bounded rationality and opportunism. These structures are organized in three ways, through the market, in a hierarchical manner, or in a hybrid way. Figure 1, adapted from Guedes (2000), presents the conceptual structure of the Transaction Cost Theory created by Williamson.

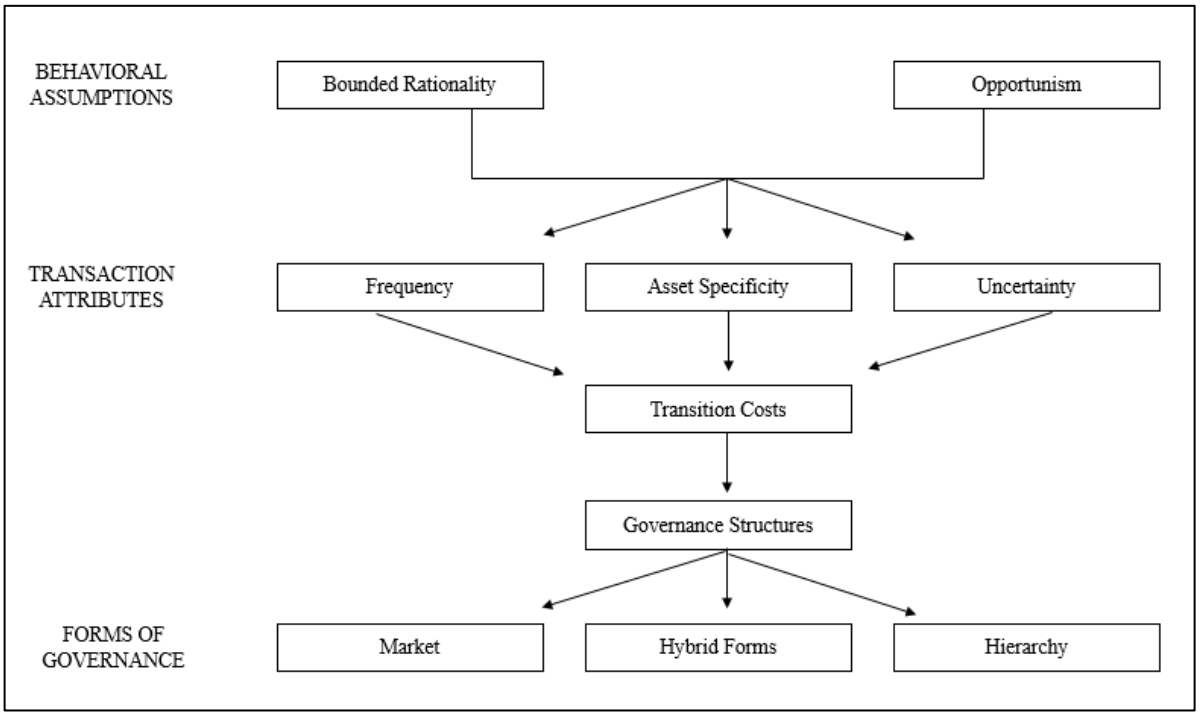


Figure 1. Conceptual Framework of Williamson's Transaction Cost Theory
Source: adapted from Guedes, 2000.

From the above, it is understood that the behavioral hypotheses and the attributes of the transactions are key elements to determine the transaction costs. Transaction expenses, unlike production costs, are more difficult to measure. In studies, these costs are generally not measured directly, but through correlations between the attributes of the transactions and the present organizational relations (Klein, Frazier, & Roth, 1990).

2.2.1. Behavioral Aspects

The first concept of bounded rationality occurred through the seminal work of Herbert A. Simon (1961). For Simon (1965), rationality is limited because it is impossible for an individual to know all the available alternatives and their consequences. Thus, his decisions will never be perfect or optimal, but satisfactory within the context where the individual is inserted.

Hence, decisions are restricted to the limitations of human beings who have no access to all the information and no cognitive capacity to process all the factors involved in a given situation. Simioni, Hoeflilch, and Siqueira (2009), and Thielmann (2013) explain this assumption by relating it to the inability of human behavior to analyze all aspects of a transaction.

Transaction cost economics assumes that agents are subject to bounded rationality, from which behavior is "intentionally" rational, but only to a limited extent (Simon, 1961, p. 24), (Williamson, 1985, pg. 30).

In Williamson's (1985) view, there are three levels of rationality: the strong form, in which agents are endowed with full rationality and are able to process all available information; the semi-strong, or bounded rationality, which is adopted in transaction cost economics; and the organic rationality, which encompasses the idea that agents have low cognitive capacity, which can generate a greater risk of problems.

The concept of bounded rationality is one of the themes that served as a basis for Oliver Williamson to construct the Transaction Cost Theory. In the concept of bounded rationality proposed by Williamson, three ideas are present: a) uncertainty, through which it is impossible or very costly to identify future events and specify the best choices linked to them; b) neurophysiological and language limitations: the mind has limitations to receive, store, retrieve, process, and analyze information without errors; c) complexity: complex decisions, implying the impossibility of listing all the possibilities and consequences of decisions (Zanella, Lopes, & Leite, 2015).

The complexity of decision-making is a factor that affects the cognition of decision-makers. Simon (1957), through the analysis of decisions in dynamic and complex environments, suggested that human beings are not able to act in a fully rational manner. This occurs due to the limited rationality of human beings who are not often mentally capable of evaluating all the potential consequences of the decisions made (Serra *et al.*, 2014).

Simon (1970) advocates that decision makers intend to be rational; however, they are incapable of operating under conditions of perfect rationality since they have limitations due to the complexity of the environment and their own cognitive limits. The author highlights that individuals are limited by certain capacity, habits, and reflexes that do not belong to the domain of their consciousness, and decision-making processes may be limited by the speed of their mental processes, knowledge, etc.

The second behavioral aspect of TCE is opportunism. Its assumption was defined by Williamson (1985), as the pursuit of self-interest, whereby agents act uncooperatively in a transaction. Furthermore, when they have privileged information, they use it for their own benefit, aiming at profit (Zylbersztajn, 1995), thus generating a selective, distorted transmission of information (Williamson, 1975), creating information asymmetry, such as, in situations where the seller knows better the quality of the product in comparison to the buyer (Caleman & Zylbersztajn, 2015).

Opportunism is not only limited to its most obvious forms, such as lying, theft, and fraud. It also includes subtle forms of baiting, both actively and passively in ex-ante costs (information gathering, agreement making) and ex-post costs, which are characterized by monitoring agreements and contracts (Williamson, 1985; Martins, 2000). These assumptions are fundamental in the understanding of economic relations. Furubotn and Ritchter (1994) defend this idea, because, according to them, in the new institutionalist literature, bounded rationality and opportunism generate all the economic problems related to contracts between agents. Given the above, the first proposition of this study is created.

Proposition 1. The existence of opportunistic behavior along with the bounded rationality of agents in complex environments indicates the possibility of higher transaction costs.

In this sense, decision makers, in this case rural producers, cannot control all the variables involved in their business environment, which does not allow them to reach a completely statistical and rational decision. Eisenhardt and Zbaracki (1992) corroborate this view, when they expose that strategic decision making is contingent and complex, directly influenced by factors such as market variability, opportunistic behavior, and time pressure, among others.

2.2.2 Transaction Attributes

Transaction costs will have different dimensions, according to the characteristics of transactions (Azevedo, 2000). Williamson (1985, pg. 56) considers that there are three attributes that distinguish one transaction from another and that, as a whole, characterize them and interfere in the costs: specificity, uncertainty, and frequency of the assets. The first one is considered the most important and the one that most distinguishes the transaction cost economy from other treatments of economic organization, but the other two play significant roles.

An asset is considered specific when it cannot be reemployed for another use without losing its value (Farina, 1997). The greater the specificity of the asset, the greater tends to be the opportunism in the action, which raises transaction costs (Mondelli & Zylbersztajn, 2008). If the specificity of an asset comes to be null, the transaction costs become insignificant and, consequently, there is no need for control. But highly specific assets have a high cost of contractual rupture (Azevedo, 2000).

Williamson (1991) identified that there can be six asset specificities: locational, physical, dedicated, human asset, brand, and time. The locational arises when the distance of

the assets involved interferes in the costs, that is, the greater the proximity, the lower the costs. For the physical, it refers to the physical attributes required to produce a given component.

Dedicated assets are investments dedicated to a given activity, for example, a grain warehouse, or a sugar cane mill. Human assets, according to Azevedo (2000), are related to human capital specific to a particular purpose. Brand is related to the construction of a name. The temporal specificity refers to the time necessary for the realization of the transaction (Williamson, 1991).

According to Guedes' (2000, pg.22) approach, uncertainty is mainly linked to the opportunistic behavior that makes the identification of possible future behavior deviations unpredictable and hinders the detection of false information by the partners involved in the transaction. Uncertainty becomes more relevant when assets are specific.

Frequency refers to the number of times a certain transaction occurs and its recurrence. That is, the more frequent the transaction, the greater the degree of dependence among agents (Belik, Reydon, & Guedes, 2007).

The relationship between the attributes of the transactions, associated with the behavioral assumptions, compose the TCE, and through its identification, help in the choice of more efficient organizational forms to govern a transaction (Ribeiro, 2000). Williamson (1991) relates the asset specificities as being the main determinant of transaction costs, and uncertainty and frequency are considered exogenous variables that can maximize or minimize costs.

In order to reduce transaction costs, agents make use of mechanisms that help regulate transactions. They are called governance structures (Williamson, 1981). For Zylbersztajn (1995), governance structures must occur due to the existence of contracts signed between agents that are subject to risks of non-fulfillment of the agreed elements. In other words, the contract does not fully guarantee satisfactory results, requiring forms of organization or governance (Neves, 2002).

There are different models of governance that differ in their form. Williamson (1981) refers to three specific types of governance structure: markets, hybrid structures, and hierarchies or vertical integration (firms).

Hambrick and Mason (1984) elaborated a seminal study that considered top management as a strategic resource and that different compositions of this structure led to different decision possibilities. This means that, based on cognitive implications and characteristics of individuals, different strategies can be adopted. This work left several gaps so that future studies can be carried out.

The first historical strands related to the Economic Theory defend that decision-making is based on a process of choice, in which the decision-maker agent, through rational decisions, will obtain an optimal choice and results. It is thus assumed that the decision maker has complete information about the alternatives and choice possibilities. The choice model based on rationality for decision making is grounded on the fact that individuals make decisions aiming at maximizing something, adopting, for this, a sequential and linear process (Stoner & Freeman, 1985).

In this line, studies of decision making focused on the agricultural environment were pioneered by Gasson in 1973. Economic theory is not convincing in explaining farmers' behavior. For many farmers, profit maximization is not their ultimate goal. Their motivations stem from values formed from farmers' sociocultural and subjective aspects (Gasson, 1973).

Complexity in decisions refers to the interdependencies of elements and factors that exist in any decision-making process. The greater the dependency between variables, the greater the level of complexity involved in decision making (Mischen & Jackson, 2008). A complex dynamic system can be thought of as a collection of interrelated variables whose structure determines the behavior of the system over time (Doyle, Radzicki, & Trees, 2008). From these arguments and concepts, the second research proposition is created.

Proposition 2. The stronger the occurrence of the transaction attributes, or the combination of these attributes with each other, the greater the complexity of the decisions.

2.3 TRANSACTION COSTS IN AGRIBUSINESS SYSTEMS

The first denomination for the agricultural production system appeared in 1957 and was named agribusiness. This term was coined by authors John Davis and Ray Goldberg of Harvard University's School of Business Administration, with the publication of the book A Concept of Agribusiness. In Brazil, the term was translated as agribusiness. According to Davis and Goldberg (1957), agribusiness is the sum of the operations of producing and distributing agricultural supplies, the production operations at agricultural units, and the storage, processing, and distribution of agricultural products and items produced from them. In other words, it becomes part of economic transactions. Goldberg (1957) extends the study of the firm, based on the work of Coase (1975), to an agricultural approach. This means that he inserts agriculture as part of a productive system. This was called the Agroindustrial System (AGS).

In this context, according to Neves, Neves, and Zylbersztajn (2006), the rural activity starts to present the knowledge of management techniques as necessary, in order to improve its competitiveness, transforming the farm into a rural company. Based on this concept, farms start to function as organizations, which require a managerial vision from rural producers and constant decision making.

Agribusiness systems can be seen as extended firms, structured by contractual relationships between actors in agriculture and industry. Different agents interact and, based on existing incentives, cooperate to generate value and reduce costs (Zylbersztajn, 2015).

The seminal work of Davis and Goldberg (1957) had great influence on studies about Agribusiness Systems, through the approach called Agribusiness Systems Approach. According to Zylbersztajn (2015), three major contributions of this work are worth mentioning in order to understand the AGS. The first is due to the fact that the authors no longer observe the agricultural firm as a single unit, but rather include it in a complete production system that includes the final consumer. The second contribution is linked to the focus given to the fact that all sectors that make up agro-industrial systems are interrelated and maintain interdependent economic relationships. The last one derives from the observation that within the value generated by a specific AGS, the agricultural sector is the one that receives the least value.

In 1968, Ray Goldberg, in specific studies on agricultural products, presented the need to understand agribusiness through a systematic vision, presenting then the concept of Commodity System Approach (CSA). Within this concept, all the participants involved in the production, transformation, processing, and marketing of a specific product are included, as well as the supply of the farms and the farms themselves, the storage operations, the wholesale, and retail. In other words, all those involved in the flow before, inside, and after the farm gate, encompassing from the production of inputs to the final consumer (Goldberg, 1968), are included, as well as the institutions that coordinate the other stages of the products, such as government and associations (Massilon, 2007).

Shelman (1991) suggested schematizing the concept presented above in a dynamic flow, according to Figure 2. Thus, AGS analysis involves the identification of the agents that comprise it, namely: consumer, retail, wholesale, agribusiness, and primary production (agricultural production). Consumers are characterized as the point where the flow of AGS products converges, because they are the ones who purchase the finalized product.

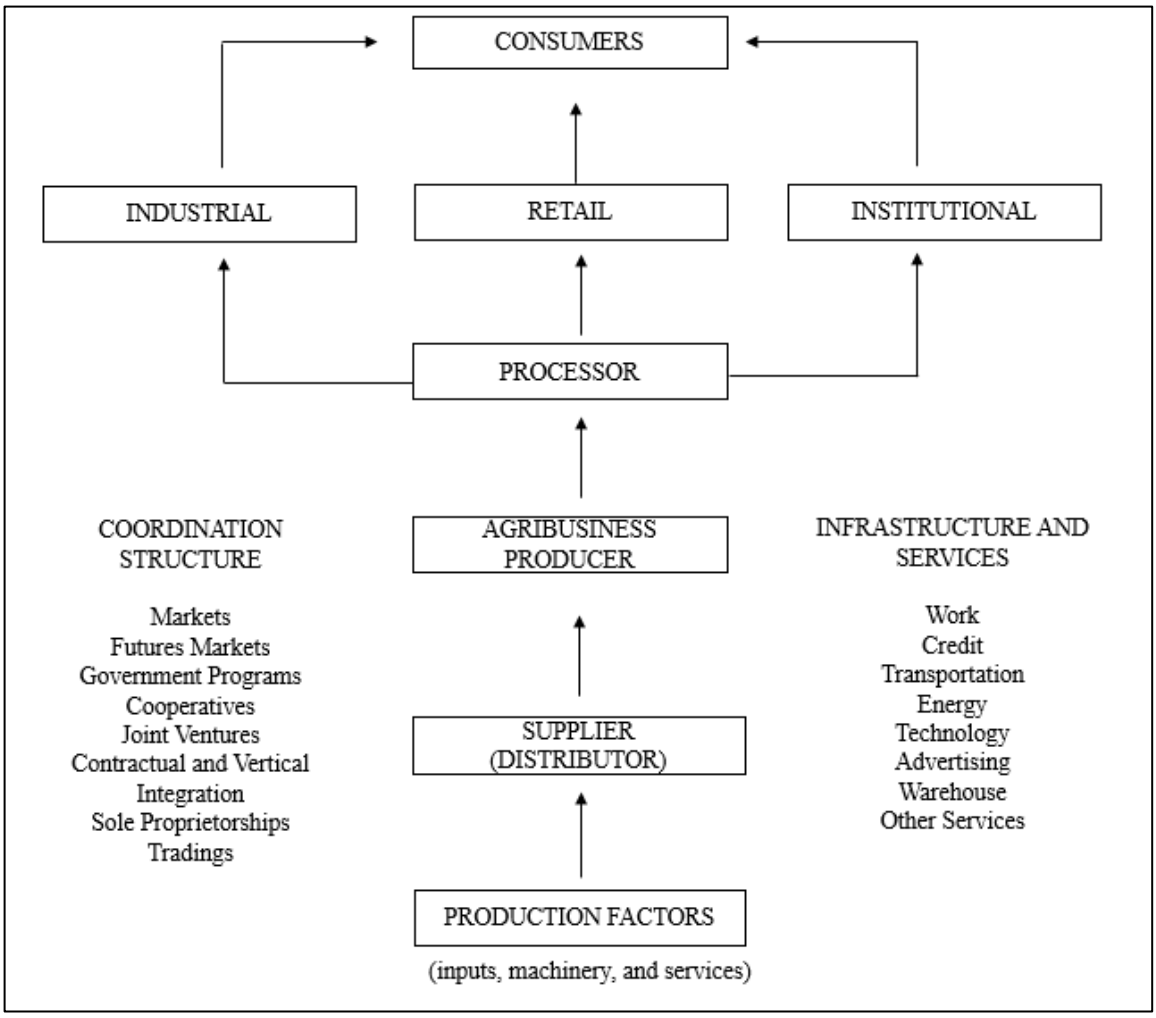


Figure 2 – Schematic of the Agroindustrial System
Source: Adapted from Shelman, (1991).

For Dutra (2008, p. 28), "[...] the agro-industrial productive chains, as a whole, as well as rural properties, are inserted in an environment of diversity and multiplicity, where interrelationships are increasingly complex". Agricultural production systems are open, multifaceted, and subject to constant exchanges with the environment, which brings with it numerous challenges. Rural producers are required to have qualified attitudes, knowledge, and skills to make choices under various internal and external influences in order to minimize the risks inherent in their business (Binotto, 2005).

Within the agro-industrial systems, the process involved in grain storage is one of the great infrastructural bottlenecks in Brazil. The country occupies the world's leading position in terms of grain volume produced during the harvest year. According to data from the National Supply Company (CONAB), the total volume of production in the 2017/2018 harvest was 227 thousand tons. Within this context, soy accounts for most of this volume. In the last harvest, the

production was of 119 thousand tons of soy. The exported volume of the soy complex (grain, oil, and bran) was 101.8 thousand tons, generating a revenue of US$ 40.9 billion.

Contrary to these positive balances, the grain storage capacity in Brazil is below the production volume. The static capacity registered today in the country is 166 thousand tons. In the last 10 years, the average growth of the storage capacity was 2.3%. While the average growth of grain production was 6.7%, according to data from CONAB (2020). Such data does not reflect the strategic and necessary nature of storage. This is because this is an extremely important stage due to its reflection in profitability, adding margin in the marketing and maintaining product quality (Burkot, 2014).

This situation reduces the competitiveness of the Brazilian producer, compared to other grain producers worldwide. Given their dependence on the availability of space in public warehouses, producers have no choice but to commercialize their production in times of less favorable prices, when the largest production volume is also being sold.

The analysis of the soybean chain shows how complex its management is, which demands a broad entrepreneurial vision on the part of producers, input suppliers, raw material processors and traders, so as to maintain and extend the competitive advantages of production (Martins *et al.*, 2005). One strategy to increase competitiveness and commercialization advantages, regarding soybean storage, is the adoption of silo structures in private properties.

Storage in private properties is still not very expressive in Brazil. According to CONAB, this type of storage is responsible for less than 20% of the total volume. As a comparison, the United States counts with 65% of storage in this mode (U. S. Department of Agriculture, 2019).

Given this situation, questions arise as to what would be the most appropriate behavior for rural producers facing the challenges of storing and marketing their harvest. Ahumada and Villalobos (2009) defend the idea that such agents must have a critical look at the chain and adopt practices that maintain their competition in the face of challenges. For this, they must investigate whether there are better ways to operate in such a globalized and interrelated chain as warehousing.

From these approaches and arrangements mentioned above, regarding the AGS, the theory of the firm and the theory of transaction costs become essential to better understand their functioning. In light of these approaches, space arises for the creation of the third proposition of this study.

Proposition 3. Transaction costs are strongly present in the context of soybean warehousing.

Brazil is the largest producer of soybeans in the world. In the last harvest, 124.8 million tons of soy were produced, a record for the country (CONAB, 2020). According to the Brazilian Agribusiness Foreign Trade Statistics [AGROSTAT] (2020), 91.8 million tons of the soybean complex were exported, of which 74.1 mi/t of beans, 16.7 of bran, and 1 of oil. Soy is one of the main and most competitive products of Brazilian agribusiness (Kussano and Batalha, 2012).

In the marketing process, the path taken by soybeans is basically from the production area to the warehouse or cooperative and, from these to the factory or port, or directly from the production area to the factory or port (Soares and Caixeta, 1997). For Pontes, Carmo, and Porto (2009), this is the moment when one of the chain's greatest bottlenecks arises. In relation to other world producers, Brazil has comparative advantages in soybean production, but faces a serious problem of outflow, which negatively affects the logistical cost of product distribution.

According to Coeli (2004), the flow of soybean production to warehouses occurs in two stages. The first is the transport from the fields to the warehouse. This is usually the producer's responsibility and is done by trucks. Its cost is high due to the absence of pavement on rural roads. It is a local and extremely pulverized transportation. The other stage occurs when the soybean is removed from the warehouses, to be directed to the export ports, or to the processing industries, to transform it into meal or oil. The fourth proposition is developed from this.

Proposition 4 – Having a silo/storage structure on the farm reduces the transaction costs for farmers.

3 TECHNICAL PRODUCTION RESEARCH METHOD AND TECHNIQUES

This section presents the research design, data collection procedures, and data analysis. It also includes comments on the limitations of the research method and technique used.

3.1 RESEARCH DESIGN

To develop the proposed theme and research, a qualitative approach research was conducted. According to Triviños (1987), the qualitative approach works the data seeking its meaning, based on the perception of the phenomenon within its context. The use of this research method seeks to capture, beyond the appearance of the phenomenon, its essence, in an effort to explain its origin, relationships, and changes, and attempt to intuit the consequences.

The research, was applied in nature. Applied research centers around problems present in activities, institutions, organizations, groups, or social actors. It is focused and engaged in the elaboration of diagnoses, also in the identification of problems and the search for solutions (Thiollent, 1997).

To obtain the proposed objectives, an exploratory research was conducted. According to Mattar (2001), the methods used by exploratory research are broad and include surveys of secondary sources, experiments, studies of selected cases, and informal observation. For Zikmund (2000), exploratory studies are generally useful for diagnosing situations, exploring alternatives, or discovering new ideas.

The procedure adopted to obtain information and reach the objectives was documental. According to Lakatos and Marconi (2007), documentary research is the collection of data from primary sources, such as written or unwritten documents belonging to public archives, private files of institutions and households, and statistical sources. Documentary research is widely used in purely theoretical research. According to Gil (1999), documentary research is of great importance when the investigation of a given problem contains much dispersed data. However, attention must be paid to the quality of the sources used, because the use of erroneous data reproduces or even amplifies its errors.

3.2 DATA COLLECTION PROCEDURES

To initiate data collection, which in a practical way allowed us to reach the proposed objectives and understand the impact that transaction attributes have on decision making, the data collection work was divided into two parts. The first was based on a systematic review to collect secondary data through the collection of case studies based on the analysis of transaction costs in the soybean storage process, or on the decision making in this chain.

According to Costa & Zoltowski (2014), the systematic review consists of the gathering and the critical and synthetic evaluation of results from multiple studies on a given research theme. Three main combinations of words were considered for searching the papers: "transaction costs in the soybean chain", "transaction costs in grain storage", and "transaction costs and decision making in agriculture". For synthesis of these studies, eight steps proposed by Costa *et al.* (2014) were used: a) delimitation of the question to be researched; b) choice of data sources; c) delimitation of descriptors for the search; d) storage of results; e) selection of

the papers by abstract; f) data collection from the selected papers; g) evaluation of the papers; and h) synthesis and interpretation of the data.

For all the search themes of the systematic research, the studies were collected from national journals in the area of Business Administration, Accounting, and Tourism, and also through search engines such as Google Scholar, Capes, and Scielo. This search was carried out between November 12 and December 2, 2020. The chronological parameter used was from 2004 to 2019. From these parameters, 15 papers were selected to be analyzed. The list of selected studies is presented in Chart 2.

No.	TITLE	AUTHOR(S)	YEAR	TYPE	SOURCE
1	The perspective of transaction cost economics in the decision-making process in productive agro-industrial chains: a proposed analytical framework	Alberto S. Dutra; Régis Rathmann	2008	Article	Sociedade Brasileira de Economia, Adm. e Sociologia Rural (SOBER)
2	Multicriteria decision analysis applied to the selection of investment in soybean storage	Patrícia D. Barboza; José G. V. Vieira	2014	Article	Revista Produto & Produção
3	Soybean purchasing and selling in the oil and bran industry in light of the transaction cost economics theory	Ana P. M. Palhano	2015	Dissertation	Fundação Getúlio Vargas
4	The railway sector from the perspective of transaction cost economics: the experience of transporting some agribusiness commodities	Andréa L. R. De O. Ojima; Valeria Comitre	2008	Article	SOBER
5	Logistics optimization of soybean and corn storage units in the state of Paraná	Adriana I. De Souza	2019	Dissertation	UNIOESTE
6	Vertical integration, strategic groups, and competitiveness: the case of the soybean agro-industrial system	Leonardo J. Sologuren	2004	Dissertation	UFU
7	Analysis of the transaction costs generated by contracts with family farmers in the agroindustrial system of biodiesel in Goiás	Camila B. Mourad; Decio Zylbersztajn	2010	Article	EnANPAD
8	Contractual relations in the soybean production chain: a case study based on transaction cost economics	Dario de Oliveira L Filho; Renato L. Sproesser; Cícero A. O. Tredezini; Eduardo Anton	2007	Article	Revista Redes
9	Transaction costs in the anticipated commercialization of soybean in the northern region of the state of Mato Grosso	Rosemeire C. dos Santos	2009	Dissertation	UnB
10	Coordination in agro-industrial systems: a study of the soybean production chain in northwest Paraná according to transaction cost economics	Alexandre R. Goldin; Gustavo A. Risso; Amanda F. Guimarães; Cristiane N. Santos	2019	Article	Revista Economia & Região

11	Transaction cost economics and transactions in the agricultural derivatives market	Léo Raifur; Paulo Mello Garcias	2008	Article	XV Congresso Brasileiro de Custos
12	The transaction costs of the productive chain of soy-based biodiesel in Rio Grande do Sul: impacts on the management of the supply chains of the installed plants	Sibele V. de Oliveira	2010	Dissertation	UFSM
13	Strategic decisions in agribusiness logistics: compensation of transportation-warehousing costs for soybean in the state of Paraná	Ricardo S. Martins; Daniele Rebechi; Celso A. Prati; Honório Conte	2005	Article	Revista de Administração Contemporânea
14	Agricultural exports and the port environment: the transaction costs theory perspective	Maria Carolina de Paulo Esteves	2017	Dissertation	Unicamp
15	Strategic alliances and resource-based view: a systemic approach to the decision-making process on farms	Alberto S. Dutra; João A. Dessimon Machado; Régis Rathmann	2008	Article	SOBER

Chart 2. Papers selected for systematic review
Source: research data (2020).

The second part is an empirical analysis, through which primary data (interviews) and secondary data (surveys generated by Research Institutes, Higher Education Institutions, and Government Agencies) were used. In Chart 3, the documentary data sources are organized, the information analyzed, and the data extracted from each one.

INSTITUTION	INFORMATION	DATA
CONAB	Soybean Production	- Historical Series Soybean Production
	Storage Costs	- Table of Tariffs for Products Linked to the Policy of Guaranteeing Minimum Prices (PGPM)
	Soybean Crop	- Soybean harvesting and planting periods in Brazil
	Freight Values	- Freight Quotation Historical Series
Crops and Markets	Freight Values	- Freight Quotation Historical Series
	Soybean Harvesting	- Percentage of soybean harvesting progress during the season
IBGE	Soybean Storage	- Stocked volume of soybeans
CEPEA	Soy Price	- Historical series of prices paid per sack of soybeans
SECEX	Soy Exports	- Percentage of exports by period
IMEA	Freight Values	- Distances and forward price from Sorriso-MT

Chart 3. Summary of collected data
Source: survey data (2021).

The interviews were conducted with two rural producers who use storage in the post-harvest of the soy crop. The choice of these two agents was based on two points: the first is due

to the fact that each one has a different experience with grain storage, which seeks to make each answer given in the interview impartial and unbiased. Besides, both are well located, close to large producing centers, which increases the supply and competition of warehouses in the region. In this way, it was possible to make a comparison between these two forms of storage in relation to the existence of transaction costs.

One of these producers, for purposes of identity secrecy, is identified in the remainder of this paper as: Producer A. His property is located in the city of Santa Helena, western region of Paraná. One year ago, this producer installed a silo structure on his farm to store his production. The second producer, here called Producer B, has a farm located in Campinorte - GO. She has no storage structure on her farm, and therefore resorts to the market to deliver her production after harvest. The two properties have similar areas and average yields.

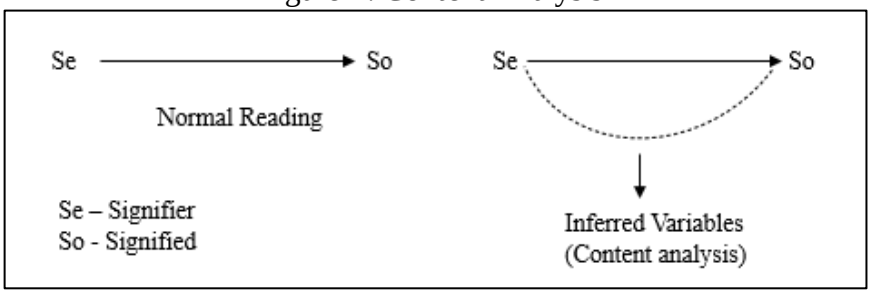
The interview with the two producers occurred online, using the videoconferencing platform "Zoom", with later transcription of the records for analysis. The interview with producer A occurred on January 12, 2021, and with producer B, on January 13, 2021.

3.3 DATA ANALYSIS PROCEDURES

Data analysis is considered one of the most important phases of the research. From this analysis, the results and conclusion of the research are presented, and may be partial, leaving gaps and opportunities for further research (Marconi & Lakatos, 1996). Having documentary research as the methodology used for data collection, the analysis step was based on content analysis that addressed the two constructs present in the investigation, besides the objective of this work, which are the attributes of transactions and the complexity of decision making.

Content analysis has two basic functions: heuristic function, through which the propensity for discovery is increased, enriching the exploratory attempt, and also the function of evidence management, because through it, evidence is expected to be found to confirm a hypothesis. The focal point of content analysis is to bring out what is hidden in the sources under study, seeking intrinsic meanings in the message (Bardin, 1977). Figure 4 illustrates this reasoning.

Figure 4. Content Analysis



Source: Bardin, 1977.

The development of the analysis is composed of three main stages, according to the organization proposed by Bardin (1977): pre-analysis of the material, description of the content, and interpretation of the results. In the pre-analysis, the choice and organization of the material is made. In this stage, documents that are in line with the research problem and the objectives are privileged. At this stage, according to Bardin (1977), the process of "floating reading" begins, through which the documents are chosen through the knowledge of their contents. Once the main documents and the registration units are identified, the second stage of this phase begins, which is a content analysis.

This stage occurs through the exploration of the previously selected material. In it, the categories of analysis emerge, besides the identification of words or expressions, themes or events that will be part of the analysis content. This step is of utmost importance because the main interpretations and inferences occur through it. In this stage, an analytical description is performed, which concerns the corpus submitted to an in-depth study, guided by the theoretical referential (Bardin, 1977). Finally, the interpretation, which is aimed at the treatment of the data collected through critical and reflective analysis, takes place.

For the analysis, the MAXQDA Analytics Pro 2020 software (version 20.2.2), a software developed for qualitative data analysis in academic, scientific, and commercial research, was used. The form of investigation for each of the constructs is shown in the following sections.

3.3.1 Transaction Attributes Construct

In order to identify the main transaction costs involved in storage structures, by studying their attributes, we first applied the systematic analysis to examine the 15 case studies that investigated the impact of transaction costs on the soybean chain and its storage process or that would provide input for the analysis.

For a more in-depth look at the studies in Table 2, the MAXQDA software allowed for detailed observation of the content by grouping segments that were coded into analysis categories and then defining the main variables to be analyzed.

Forty-three segments were coded. Subsequently, 13 subcodes or categories of analysis were created. These subcodes were grouped again, in order to understand the level of impact that each of these categories would represent. In this way, it was possible to verify the recurrence of each of the categories of analysis, in each of the case studies surveyed. The summary of the codes and variables is shown in Table 4.

N	Number of Coded Segments	Subcodes	Codes
1	0	High Physical	Specificity
2	2	Low Physical	
3	5	High Temporal	
4	1	Low Temporal	
5	8	High Locational	
6	0	Low Locational	
7	2	Price	Uncertainty
8	6	Contract	
9	6	Crop (weather and production)	
10	3	Freight Seasonality	
11	7	Opportunism	
12	3	High Frequency	Frequency
13	0	Low Frequency	
TOTAL	**43**		

Chart 4. Case study analysis categories
Source: Research data, 2021

The second stage was constituted by an empirical analysis and the attributes of the transactions evaluated were the following: asset specificity, frequency, and uncertainty. For the analysis of the specificities, the main focus was given to the physical, locational, and temporal. To this end, freight price data and the impact that displacement distances have on this indicator were analyzed, in addition to the agricultural harvest calendar and storage rate price history, through data from the National Supply Company (CONAB). The higher the uncertainty level, the greater the risk involved in a decision, and thus the categorization of low, medium, and high was also applied in this case, for understanding the variable price as an impact factor of uncertainty.

Such data allowed us to analyze whether distance and specific structures for the installation of warehouses intensify such specificities mentioned above and consequently the transaction costs. For this, these costs were classified in levels of low, medium, or high specificity. This information was collected through documentary analysis of reports from portals such as the Freight Information System (*Sistema de Informações de Fretes* - SIFRECA), the National Land Transport Agency (*Agência Nacional de Transportes Terrestres* - ANTT), and the Storage Information System (*Sistema de Informações de Armazenagem* - SIARMA).

For uncertainty analysis, the historical soybean prices were used to allow understanding if there is variation in the price of this commodity at certain times of the year. This directly influences producers' level of uncertainty, making them dependent on the market. In addition to this indicator, freight prices also served to support this stage. The collection of this information occurred through documentary bases of the Center for Studies and Research in Applied Economics (*Centro de Estudos e Pesquisa em Economia Aplicada* - CEPEA) and the Institute of Agricultural Economics (*Instituto de Economia Agrícola* - IEA). For frequency analysis, storage volume data correlated to soybean production volume over three years was studied. The aim was to understand if the ratio between storage and production is constant. The data on storage were collected from CONAB, SIARMA, and the Ministry of Agriculture and Livestock (MAPA). This attribute was also classified into high, medium, and low frequency.

For the second goal to be achieved, the relationships between governance structures, transaction attributes, and complexity in decision making were analyzed. From the analysis of the attributes of transaction costs, it was possible to determine in which combinatorial scenarios of intensity of these attributes the complexity of decisions becomes greater or lesser. From there, an analytical model can be created to understand in which attribute combination scenarios the decisions might be less or more complex. Finally, and after structuring the previous items, it was possible to analyze in which of these modalities there is a scenario in which decision making becomes simpler and with the possibility of more programmed choices.

3.3.2 Decision-Making Complexity Construct

All the steps previously presented served as support so that the last specific objective could be reached. To this end, an analytical structure of interaction between asset specificity, frequency, uncertainty, and the governance structures used in each type of transaction was elaborated.

Subsequently, the same reasoning of interaction between attributes was used, extrapolating it to the analysis of decision-making complexity, in order to illustrate how the intensity and combination of each one of them affects the decision. It was possible to demonstrate how decision making can vary according to the type of transaction within this soybean storage process. Then, with the results obtained, it was possible to analyze whether the four propositions elaborated in the theoretical framework could be confirmed or not.

3.4 LIMITATIONS OF RESEARCH METHODS AND TECHNIQUES

In general, all research methods have strengths and limitations. The same happens with documental analysis. In this sense, Yin (2001) highlights some limitations of this method, such as having biased views based on the author's preconceived ideas, the tendentious selection of documents that are in line with the research objective, and also the difficulty in accessing certain sources of information.

Another limiting point is the method's own categorization that, by being structured in a schematic way, may not provide clarity and depth to the content of the sources (Flick, 2013). Thompson (1995) also adds that in this methodology the researcher tends not to be neutral and calls this tendency the "myth of the passive receiver"; thus, the absence of neutrality in the interpretation of the sources can be considered a limitation.

Finally, as pointed out by Mozzato and Grzybovski (2011), Content Analysis enables the use of different analysis strategies in its methodological development; however, at the same time, it signals its limits and underlying fallacies. Thus, the search for validity and reliability criteria constitutes a path to overcome the limitations, inherent or not, to the technique itself.

4 CONTEXT OF THE PROJECT OR PROBLEM-SITUATION

Decision making requires the analysis of the maximum number of variables in order to get as close as possible to an ideal choice. In dynamic, complex, and changing environments, this becomes even more difficult, since it requires agents to have a systemic view of the context.

The more complex this context is, the more complex the decisions will be, as they will be surrounded by uncertainties, information asymmetries and incomplete information, limited resources and rationality, multiplicity of objectives, and conflicts of interest. Thus, the study of decision making should involve as many variables as possible, whether endogenous or exogenous, such as the uncertainty involved in the transactions, the frequency with which these transactions occur, and the specificity of the assets that will be worked on. This scenario is fully applicable to the management of supply chains in agribusiness, since it involves a series of specific decisions resulting from an increasing complexity of elements involved in its network.

5 RESULTS ANALYSIS

The first stage of this topic consists of the presentation of the results obtained from the systematic analysis of the papers that contained case studies using the software Maxqda. In a second topic, the main results obtained with the empirical studies are presented. They were obtained through the documentary analysis and the interviews conducted with two farmers.

5.1 SYSTEMATIC ANALYSIS

Through the reading of the 15 case studies, and with registration of the segments that fit the analysis studied in this paper and subsequent identification of the codes, it was possible to see which attributes appeared most recurrently within each study. The result is illustrated in Figure 5 and onwards.

Figure 5. List of codes and their occurrences in the documents.
Source: Research data, 2021.

The number of returns resulted from each document analyzed are in the columns. The number of returns for each of the codes and subcodes created are in the rows. The circles vary in intensity according to their color and size. Larger and redder circles indicate that the number of times a given code and subcode appeared in each of the documents analyzed was greater.

Twenty-four segments were identified concerning the uncertainty attribute. Thus, among the case studies, this is the factor with the greatest impact in the soybean grain storage context. Next, asset specificity recurred in 16 distinct segments. Finally, the attribute frequency of transactions was the category with the lowest number of returns, with only three highlights.

With the analysis of the case studies, it is clear that the specificity is a very relevant attribute in the soybean storage scenario. The existence of high location specificity was

presented as a determining factor in the decision-making process for choosing the location for implementing the storage structure, as well as presenting a strong impact on the transactions that involved the transportation of grains to the storage locations (Figure 6).

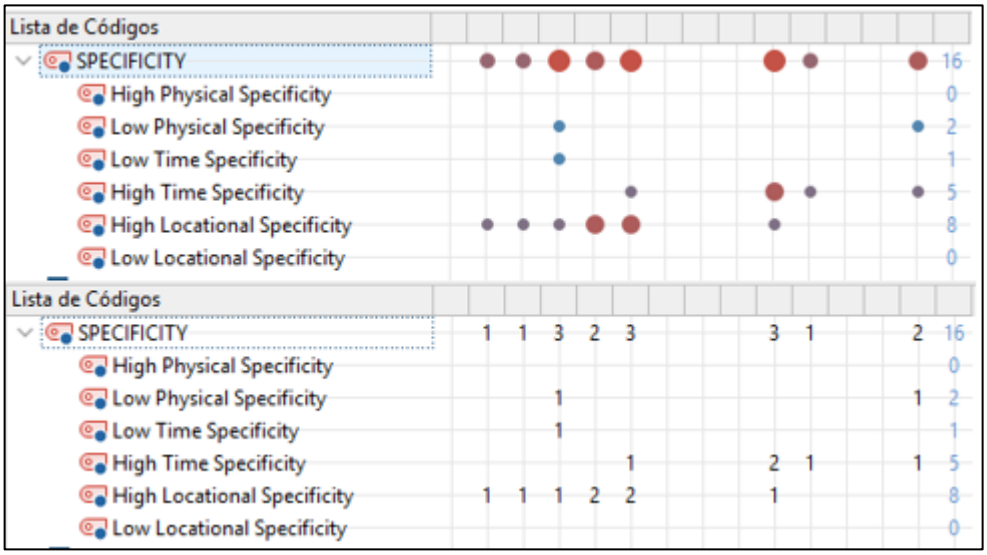


Figure 6. Code Occurrence Specificity
Source: Survey data, 2021

The code Uncertainty returned 24 segments (Figure 7). This was the attribute with the highest recurrence in the analyzed studies. Within this code, the subcodes contracts and harvest appeared six (6) times and Opportunism, seven times. The uncertainty due to seasonality of freight prices and the change in prices of the soybean bag, appeared three (3) and two (2) times.

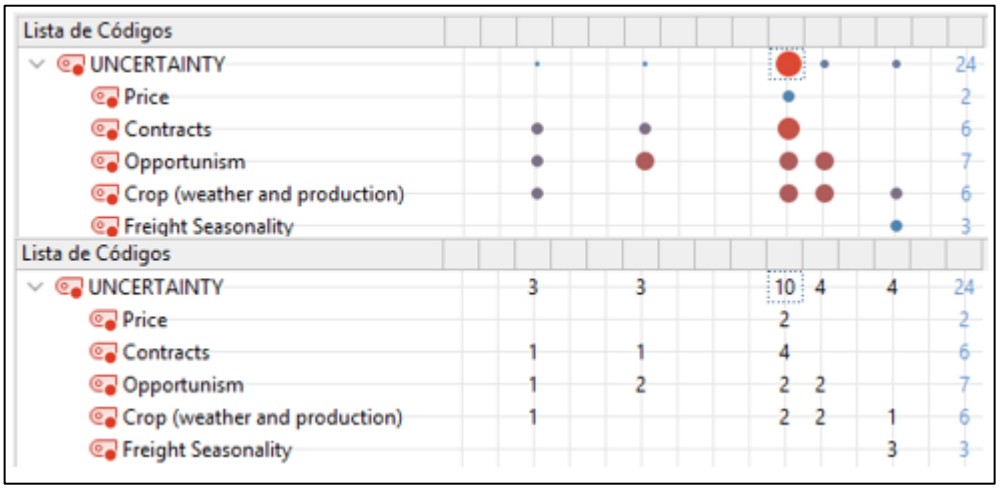


Figure 7. Recurrence of the uncertainty attribute in the case studies.
Source: research data, 2021.

It is noted that much of uncertainty is caused by the frequent incompleteness of contracts between producer and originators. However, opportunism in this context appears as an

aggravating factor. It is already known that soy production is a specific asset, which implies that it is subject to the opportunistic action of the industry.

Frequency was the code that had the fewest highlighted follow-ups. It added up to only three (3) occurrences. When analyzing the relationship between producers and a soybean buying and storage company, Goldin, Risso, Guimarães, and Santos (2019) identified in their study that contracts were made annually, during the crop harvest. This was characterized as a recurring frequency in this transaction (Figure 8).

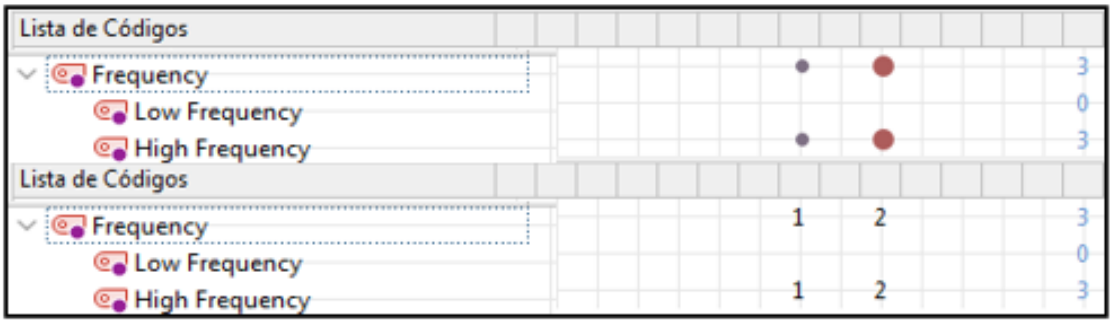


Figure 8. Recurrence of the attribute frequency in the case studies.
Source: survey data, 2021.

Systematic research played a key role as a basis for advancing empirical research. The case studies served as a starting point and endorsement for the results obtained in the following stages. In addition, the findings of this step are in line with the ideas proposed in the formulation of the propositions.

5.2 EMPIRICAL ANALYSIS

5.2.1 Document Analysis

Sometimes, due to the lack of warehouses or by choice of the producer or shipper (given market supply and demand conditions), the harvested crop can follow directly from the rural property to the port of destination or to the processing industry that generally keeps its stock near its facilities (CNT, 2015). In this context, locational specificity becomes an even more limiting factor for storage, when the freight costs for different trips are analyzed (Chart 5).

	City of Origin - Sorriso			
Destination City	**Mirituba**	**Paranaguá**	**Rondonópolis**	**Santos**
Distance	**1,075 km**	**2,219 km**	**665 km**	**2,050 km**
Shipping Price 1 qrt	202.72	257.96	109.86	283.67
Shipping Price 2 qrt	180.90	241.60	98.71	275.62
Shipping Price 3 qrt	209.85	279.77	112.60	293.31
Shipping Price 4 qrt	159.83	238.00	96.42	287.92

Chart 5. Comparison of distances and forward price from Sorriso-MT
Source: IMEA (2020).

The closer the warehouse is to the property, the lower the transportation costs will be for the rural producer. In situations where it is necessary to send the production directly to the port of Paranaguá, for example, the producer, located in Sorriso, is subject to pay almost three times more than if he could send it to the city of Rondonópolis, for example. In case he has a warehouse on his property or there is free space in warehouses nearby, this cost drops significantly.

As for the temporal specificity, the impact that time has on storage is analyzed below. Soy is a seasonal product, that is, it is only produced at specific times of the year. The planting and harvesting calendar is shown in Table 6. In general, harvesting begins in the South of the country, starting in September. In the Midwest, from October on. In both regions the harvest starts in January and continues until April.

The harvest season is thus characterized between the months of January to April, when the harvest occurs. The off-season occurs between the months of June and December, since the supply of grain is greatly reduced during this period. From this point, we understand that time is an important factor for the crop, given that its availability and supply is limited at certain times of the year (Table 6).

	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
South	P	P	P	P	C	C	C	C				
Midwest		P	P	P	C	C	C	C				

Chart 6. Soybean crop calendar in Brazil.
P = Planting; C = Crop Harvest.
Source: CONAB, 2019.

There is no standard in the collection of storage fees by the terminals that store grains. As analyzed by Kussano *et al.* (2013), some terminals charge a fixed amount for the first fortnight and an additional amount per exceeding period, which can vary between daily, half-

day, and even fortnight. There are still warehouses that charge an entrance fee and an additional fee per fortnight.

The storage fees at the terminals are, in most cases, linked to the transshipment fees. Due to this lack of tariff standardization, we considered the storage value at CONAB warehouses for analysis, which includes the storage fee, cleaning operations, drying, surcharges, administration fees, and transshipment.

The surcharge levied by CONAB varies fortnightly. It is set according to the economic value and risk of weight loss of the goods. To extrapolate the calculations, the values for the 15-day period from October 16 to October 31, 2020 were considered. The calculations regarding storage costs over six months are presented in Table 1.

Months	GO	MS	MT	MG	SP	PR	RS	SC
1	56.67	57.32	57.41	57.15	56.60	56.67	57.12	56.80
2	63.06	64.36	64.54	64.03	62.93	63.06	63.96	63.32
3	69.44	71.40	71.67	70.90	69.25	69.45	70.80	69.84
4	75.83	78.43	78.80	77.77	75.57	75.83	77.65	76.37
5	82.22	85.47	85.93	84.65	81.89	82.22	84.49	82.89
6	88.61	92.51	93.06	91.52	88.22	88.61	91.33	89.41

Table 1. Monthly cost of soybean storage in CONAB's warehouses (R$/t).
Source: elaborated by the author based on data from CONAB (2020).

One of the relevant points for decision making at this stage is the perception of factors linked to the seasonality of agricultural production, which influences the concentration of its supply in certain periods, especially those linked to the harvest period (Rathman, Silveira & Santos, 2008). Economic theory explains that both abundance and concentration make the product scarce, causing the prices of these products to fall during their harvest and in periods close to their occurrence.

To understand how the soybean price varies during harvest, and how it can influence the uncertainty factor, the average monthly amounts paid for a 60 kg soybean bag in the last two years in the state of Paraná were calculated, according to a survey carried out by the Center for Advanced Studies in Applied Economics (CEPEA). These values are presented in Table 7.

MONTH/YEAR	2018	2019	2020
JAN	67,42	72,02	82,60
FEB	69,43	72,78	81,45
MAR	73,64	73,02	88,23
APR	79,60	71,78	95,19
MAY	80,32	72,91	103,34
JUN	78,44	76,26	103,43
JUL	81,97	73,78	109,45
AUG	83,64	78,74	122,52
SEP	88,84	80,44	136,72
OCT	84,18	82,63	158,41
NOV	78,33	84,28	164,55
DEC	75,60	83,31	145,12

Chart 7. Average values paid per sack of soybean in the State of Paraná in the last three years.

Source: CEPEA, 2021.

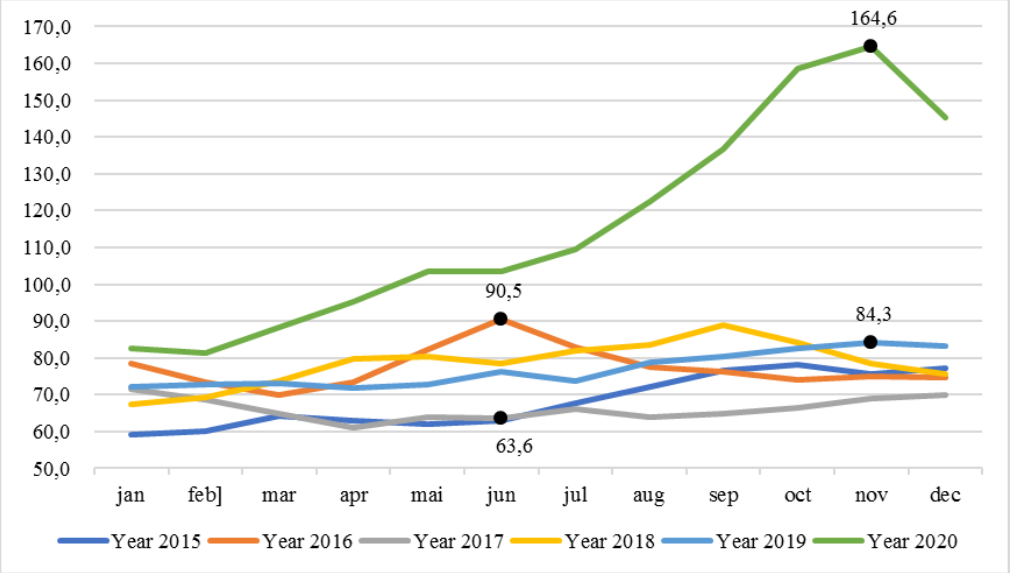
From the table above, it can be seen that prices fluctuate throughout the year. In general, the months with less attractive prices for soybean sales by farmers are January, February, and March. This period concentrates the peak of the harvest, i. e., the biggest offer of the product in the market. From April until July, prices tend to start improving. As of August, the prices paid for the soybean bag tend to become better due to the lower product offer in the market.

Thus, the impact of the harvest and off-season on soybean bag pricing is clearly understood. Despite such oscillations expected throughout the year, as it is a commodity dependent on foreign markets, demand variations, and weather conditions, the soybean chain deals with scenario variations every year. In 2020, soybean bag prices reached record values caused by several factors, such as the exchange rate increase, heated demand from China (the largest consumer of Brazilian soybeans), which led to a reduction in domestic stocks, and domestic demand, which remained heated. Graph 1 shows soybean bag prices at the port of Paranaguá from 2015 to 2020. Through the behavior curves, it is possible to note how the oscillation in pricing is constant in the soybean business.

Even in harvest periods, when a drop in prices is expected, and in the off-season periods, when prices rise, the behavior of prices does not remain stable and in comparing years (Chart 1). In June 2016, for example, the highest price was paid (R$ 90.50). In June 2017, one of the lowest prices for grain (R$ 63.60) in the year occurred. This scenario proves how the price factor is an important aggravating factor of uncertainty on the part of producers and the market. In relation to storage, this context has enormous relevance, because with their own storage

structure, producers could choose the most favorable moment to commercialize their production and increase their profits.

Graph 1. Soybean quotation (R$/saca 60 Kg) from 2015 to 2020 in the port of Paranaguá/PR

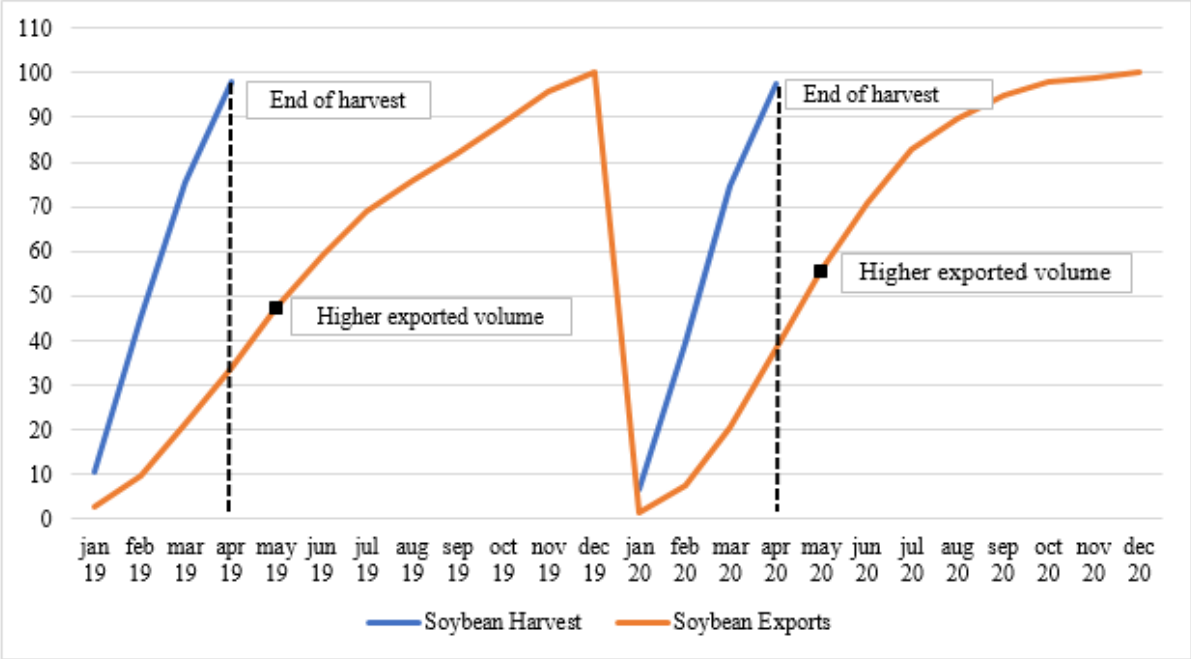


Source: CEPEA (2021)

Another item causing uncertainty, present in the Case Study analyses, was the variation in freight prices. Similar to the price paid for the soybean bag, price oscillations also occur in the freight market during the crop year. After the harvests begin, there is an increase in demand for truck transport, because the commercialization occurs immediately due to the insufficient static capacity in Brazil. Additionally, a large part of the harvested volume goes straight to the export ports. As a result, freight prices rise.

It is noticeable that after the end of the soybean harvest in Brazil, which historically occurs at the end of April, the volume of soybean exports increases. Therefore, since the beginning of the harvest, there is strong pressure for transportation. The month of May, in the last two years, has concentrated the highest exported volume. Thus, it is expected that in the first semester of the year, the highest freight values will occur (Graphic 2).

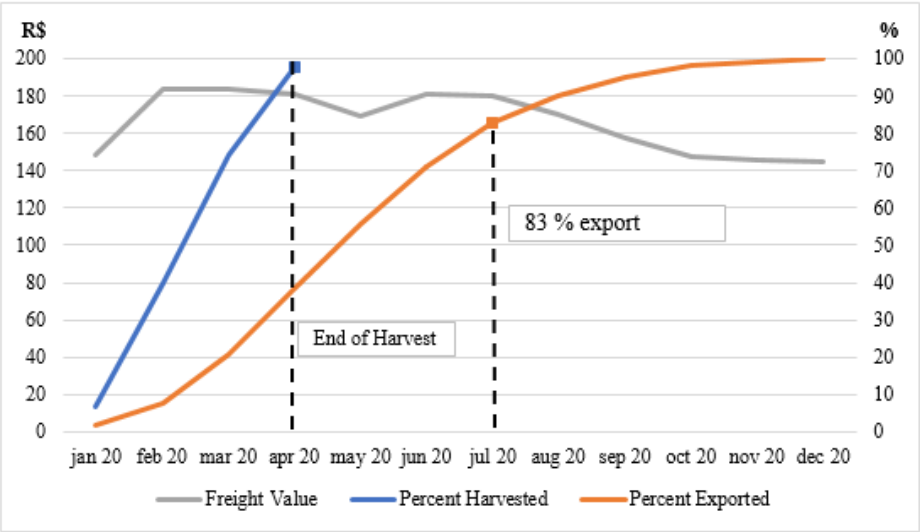
Graph 2. Harvest pace versus export pace for soybeans



Source: Secex, CONAB, Safras e Mercado (2020).

Complementing the information presented in the previous Graph, Graph 3 includes the freight price. At the end of the harvest, in mid-April, the value of freight prices (Brazilian average) begins to show signs of decline; however, as there are still soybeans in warehouses or awaiting drainage, this price reduction is not yet so significant. As of July, when a large part of the harvest (83%) has already been exported or drained, a more considerable flow of drops in freight rates begins, because there is little volume of grain available for transportation.

Graph 3. Soybean exports, harvest march, and freight prices

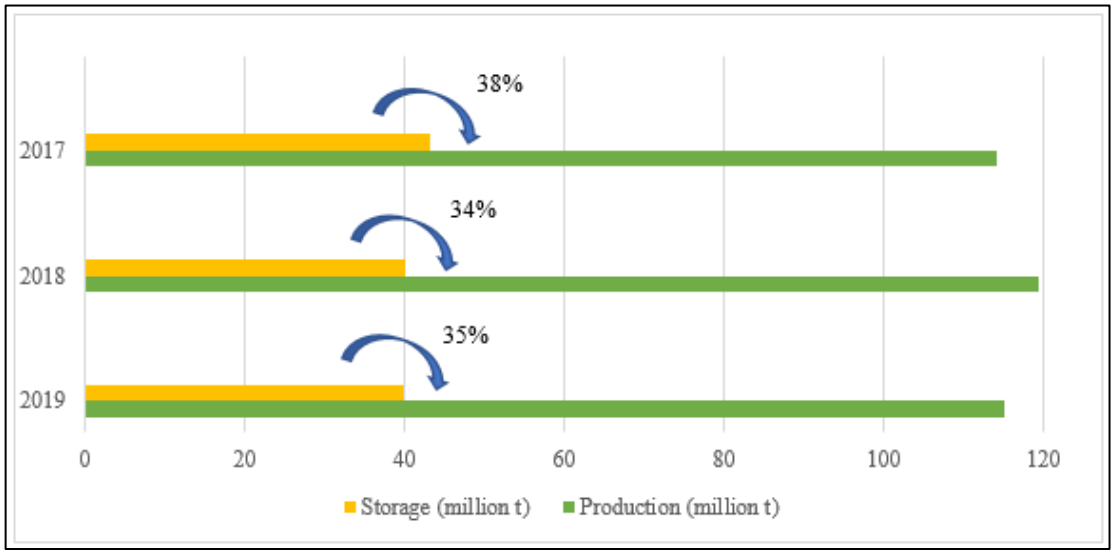


Source: Secex, CONAB, Safras & Mercado, and IMEA (2020).

Among the three possible paths that soy can take after its harvest, every year a percentage of the harvested volume of soy is destined for warehouses. In the last three years, according to IBGE and CONAB annual surveys, between 30% and 40% of the production was stored. This storage includes conventional warehouses, bulk warehouses, and silos, whether public, private, cooperative, or mixed economy.

In 2019, production was 115 million tons and the volume stored was 40 million tons, meaning that nearly 35% of the crop was stockpiled. In 2018, production was 119 million tons, and 40 million tons were stored, representing 34% of the total volume. In 2017, production reached 114 million tons and soybean storage stood at 43 million tons; therefore, 38% of the volume went into storage (Chart 4).

Graph 4. Soybean production and storage between the years 2017 and 2019, in millions of tons



Source: IBGE and CONAB (2021)

Based on these data, one can see that every year the destination of part of the harvest to storage structures is recurrent. Thus, it is noteworthy that the frequency of the transaction between producer and warehouses (trading, private companies, cooperatives, and originators) is high. Nevertheless, the same cannot be said about the recurrence of transactions between producer and the same storage partner. This evidence becomes clearer when analyzing the interviews conducted with producers following this study.

Aiming to create a connection between the two study constructs of this work, it was noticed that the correlation of the governance structures pertaining to the Transaction Cost Economics with the attributes of the transactions could open the way to create a parallel of this structure with the analyses of the complexity of the decisions. This is because, by analyzing the transactions resulting from the variable combination among the attributes, in levels of intensity, it was possible to notice that there are different levels of complexity in these relations.

Thus, it was first necessary to understand what they are, their purpose, and what are the main governance structures that make up the TCE Theory. Williamson (1985) argues that the proper functioning of a production system does not depend only on the effectiveness with which each segment solves the problems that arise at each stage, but that the more coordinated the action between the segments of the system, the lower the costs of each of them, the faster the adaptation to the dynamics of the environment, and the less impactful the conflicts inherent in the relationships of this system will be.

Based on Williamson's studies (1979, 1985, and 1989), and later on Zylbersztajn's (1995 and 2000), the main concepts regarding governance structures and how they are organized, according to the levels of transaction attributes, will be presented.

According to Williamson (1985), in the governance structure via market, the level of assets specificity is low; therefore, the transaction costs are minimum. The frequency of transactions can be recurrent, and uncertainty is low, because, as pointed out by Menita, Vanelle, Salles, and Daher (2011), with low specificity as a condition, even with a high level of uncertainty, there will be no difficulty in overcoming uncertainty, and the market is still, and therefore, the best way to reduce transaction costs.

Less specific assets can make use of broader and wider governance structures, such as the market, which is the least specialized of the three forms. Assets that have a high degree of specificity are more dependent on more specialized governance structures (Fiani, 2011).

The hierarchy or vertical integration is motivated by situations in which there is high or medium specificity of assets (Zylbersztajn, 1995). This can be due to restrictive particularities of the asset itself, quality requirements, location, or even the complexity of the productive process. In this governance structure, transaction frequency is recurrent, with frequent and continuous supply. And the uncertainty is also medium or high. In these cases, there is a decision to centralize the process within the same business structure, aiming to reduce uncertainty and risk as much as possible (Menita, *et al.*, 2011).

Besides the governance structures previously elucidated, it is also possible to organize in a mixed or hybrid way, through agreements between the parties. This acts as an alternative

to pure vertical integration and governance via the market, considering the specificity of the assets and the particularities of the production system (Trentin and Lago, 2017). This structure is used in transactions where asset specificities are medium to high, making the market inefficient to conduct the transaction, and the hierarchy quite costly bureaucratically.

Within this structure, as the parties relate to each other, the use of informal mechanisms such as reputation, trust, information sharing, and mutual help increases, as they are used in the relationship between the agents (Ménard, 2004). For Williamson (1991), this structure permits long-term contracts, allowing autonomy of the parties involved, and simultaneously provide greater guarantees in relation to the market structure, because they allow adaptations arising from the characteristic of incompleteness of contracts. Schematically, in Chart 8, governance structures are presented along with the different combinations of transaction attributes.

		UNCERTAINTY				
		Low	***Medium***	***High***		
SPECIFICITY	***High***	Hybrid	Hybrid or Vertical	Vertical	***High***	**FREQUENCY**
	Medium	Hybrid	Hybrid or Vertical	Hybrid or Vertical	***Medium***	
	Low	Market	Market	Market	***Low***	

Chart 8 - Governance structures and sets of transaction attributes.
Source: Adapted from Williamson (1989) and Zylbersztajn (1995).

Transaction is the basic unit of analysis, and governance is a mechanism to establish order in relation to potential conflict threats, to take advantage of opportunities, and to realize mutual gains. Therefore, governance is a coordination structure in which the members of the transaction (institutions and agents) make decisions in order to minimize their economic costs, and the more efficient governance is, the lower the transaction costs (Williamson, 1999).

5.2.2 Interview with Rural Producers

In order to complement the documentary analyses, as well as bring more support for the conclusions regarding the propositions, and an empirical view from agents acting in the market,

an interview was conducted with two farmers who produce soybeans on their properties. Thus, it was sought to ascertain information from the practical experience of these agents.

Producer A, with a farm in Santa Helena - PR, has a warehouse on his property. Producer B, who produces in Campinorte - GO, has no storage structure on his property. From these interviews, it was possible to understand the reasons why each one has chosen different paths to deliver their production, as well as to understand how opportunism, uncertainty regarding the price of the soybean bag and freight, and the complexity of the decisions interfere in the transaction between them and the storage players. The answers were organized into subject topics, as follows:

a) **On the decision of whether or not to invest in a storage structure:** Producer A affirmed that the acquisition of the silo was facilitated and made possible through the PCA - Construction and Expansion of Warehouses, which is a credit line from Banco do Brasil for financing storage structures:

> "We applied for financing two years ago, but it only came out a year ago. Even though it took longer than expected, for us it will be great. The interest rate was 6% p. y., because our silo holds 10,000 tons.

Producer B is currently capitalizing on other farm structures, such as planting and harvesting machinery and a pivot structure. However, there are future plans to invest in silos.

b) **Decision Autonomy:** For both producers, there are two main motivating factors to consider the acquisition of a silo. The first is the possibility of choosing the time of more favorable prices for the sale and thus obtain better returns. **Producer A**, besides claiming greater autonomy over his commercialization, is still working in partnership with regional producers and storing the production of other farms, which allows an even greater gain in relation to the years when he did not have this structure on his property, as highlighted:

> "Besides being able to store my production for as long as it is better for us to commercialize it later, we already have agreements with some neighbors to store part of their production. Both corn and soybean. I will charge a lower rate than the cooperatives and trading companies here in the region, and it will still be profitable for me and they will have less expenses.

c) **Opportunism:** The second main motivator is due to the existence of opportunistic behavior on the part of the storage companies. According to both producers, opportunism occurs mainly due to discounts on moisture and grain quality at the time of cargo reception.

Generally, the companies tolerate that the grains have humidity between 14% and 18%, and impurities between 1% and 3%, with discounts of 3% to 5% for burnt and damaged grains. From these values on, there start to be discounts in the amounts paid for the cargo.

The producers perform such measurements on their properties, and from these measurements, they calibrate the rates for each quality specification. However, at the time of delivery and verification of production by the buying company, these rates often vary to values above those previously measured by the producers, and they then receive payment from the measurement made by these companies. Such clearly opportunistic behavior discourages producers from continuing their partnership with these companies and, consequently, motivates them to have their own storage structures. Producer B endorses this point when he states that he has changed partners when delivering the grain, due to abusive discounts:

> "We have already suffered enough with the abusive discounts for humidity and also for impurities, which makes us very frustrated. My father regulates the machines personally and always certifies the quality of the grains. It certainly is a stimulus to invest in the silo structure [...] we changed our delivery partner this year, because the warehouse closest to the farm was practicing abusive discounts, which we didn't find fair in the last harvest".

Producer A also agrees with this idea, because before having his own structure, he used to evaluate every year which company he would deliver his grain to. According to the behavior of that company in the previous harvest, this producer changed partners in the following harvest.

d) **Frequency:** From these positions, it can be seen that the frequency of occurrence of transactions between producer and buyer/stocker may vary yearly, which does not characterize a strong frequency in this transaction. **Producer B** reinforces:

> "...we always observe the discounts made on the trucks; some warehouses discount more than others. And lastly, we also always quote the prices at each warehouse, and we have already found variations during the year."

e) **Locational specificity:** Along with these two motivators mentioned above, the location of the company that will receive the grains also has great relevance at the moment of choice. Producer B said that in the last two years they worked with a company that was located a few kilometers from the property, which generated great freight savings. However, due to the abusive discounts that this company had been practicing, they opted to deliver their production

for this harvest to another company located farther from the property, but which was offering more attractive prices for the cargo. With an offer of payment of about 2 to 3 Reais more per soybean bag.

> "...company X, in Anápolis (270 km from Campinorte) pays 2 to 3 reais more per bag, which compensates for the freight to deliver there."

f) **Decision-Making:** Regarding decision making, producer A stated that the most complex moment or transaction is precisely the choice of the ideal moment to sell the production. The uncertainties regarding the price to be paid per bag and the freight price, which, according to him, may fluctuate weekly during the harvest, are factors that make decision making quite complex. Producer B recognizes that the fact that she does not have a silo on her property makes the whole storage process quite complex, since it is in the hands of the buying/storage company, and that the decision about prices and contracts is often made by the company that receives the grain:

> "The sale of the crop is more complex regarding the sale moment. Being assertive at that moment is the most complicated, due to the oscillations of the market."

Based on the interviews presented above, the MAXQDA tool was used again to analyze the segments and thereby understand if there is a correlation between the attributes and behavioral hypotheses, which are opportunism and bounded rationality, and the answers given by the producers, so that it is possible to sustain each of the propositions made. Twenty-three segments were highlighted in the two interviews, and grouped into seven analysis categories, which were the complexity of decisions, uncertainty, bounded rationality, locational specificity, opportunism, frequency, and autonomy in decisions. The maps with the correlations between the codes are presented in Figure 9.

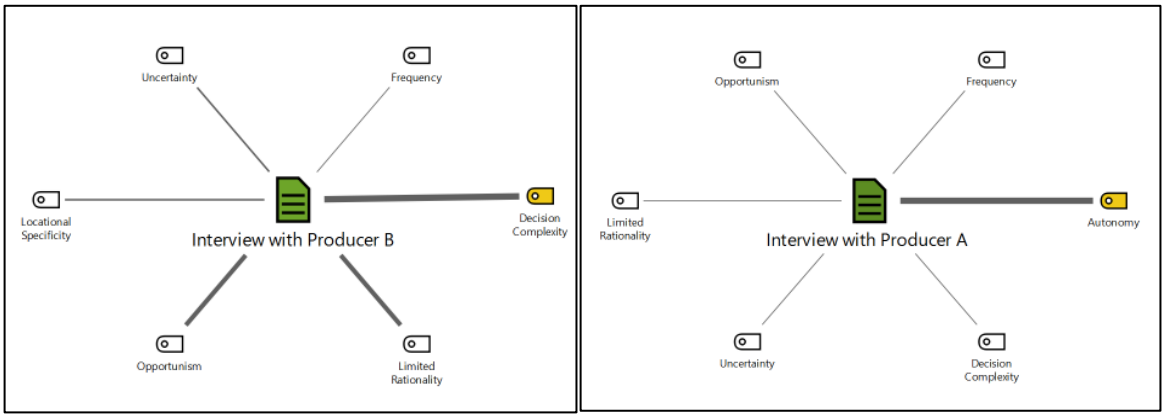


Figure 9. Correlation map between behavioral attributes and hypotheses.
Source: survey data, 2021.

The greater the correlation between the categories of analysis, the more intense and stronger is the scheme line. Based on the analysis of the maps, it is understood that the greater the occurrences of transaction attributes and behavioral hypotheses, the greater the occurrence of complexity in decision making. Since producer B does not have her own structure for grain storage, she is more susceptible to transaction costs and therefore less able to make decisions.

Producer A, who has a storage structure, showed less correlation between the attributes, hypotheses, and complexity of decisions. In this context, an extra segment was identified, called autonomy. That said, it is understood that by having less influence from the transaction attributes, the greater is his autonomy in terms of decision-making, which consequently makes them less complex.

5.2.3 Proposition Analysis

From the empirical studies, which include document analysis and interviews, it was possible to evaluate each of the propositions and thus confirm or refute each of them. Regarding opportunism as a cause of uncertainty and the arguments found in the interview with the producers, it is possible to **confirm proposition 1**, that the existence of opportunistic behavior, along with the bounded rationality of the agents in complex environments, in which certain agents possess privileged information, indicates the possibility of higher transaction costs.

From the analysis of Table 8, **proposition 2 can also be confirmed**. The stronger the occurrence of the attributes, or the combination of these attributes among themselves, the greater the complexity of decisions, therefore, the greater the need for a robust governance structure with greater transaction control.

Having discussed all the above points regarding transaction attributes in the context of soybean warehousing, it is possible to **confirm proposition 3**, through which it is inferred that transaction costs were strongly present in warehousing transactions due to the close relationships and negotiations between this segment and rural producers.

We can also **confirm proposition 4**, since the governance structure of vertical or hierarchical integration, here represented in the structuring of a storage unit on the property, reduces transaction costs and the complexity of decisions, and also generates a positive return to the producer for being able to commercialize his production at an opportune price time. Thus, the verification of the analyzed propositions is concluded. Table 10 presents a summary of the results of the propositions investigated.

Proposition 1	The existence of opportunistic behavior, along with the bounded rationality of agents in complex environments, indicates the possibility of higher transaction costs.	**Confirmed**
Proposition 2	The stronger the occurrence of the transaction attributes or the combination of these attributes with each other, the greater the complexity of the decisions.	**Confirmed**
Proposition 3	Transaction costs are strongly present in the context of soybean warehousing.	**Confirmed**
Proposition 4	Having a silo/storage structure for soybeans in the farm reduces the transaction costs for the rural producer.	**Confirmed**

Chart 9. Summary of the verification of the propositions

Source: survey data, 2021

6. DISCUSSION OF RESULTS

Williamson (1985, p. 86) considers Specificity the most important of the three dimensions. According to the author, without the specific assets, the negotiations and contracts would be simplified, because there would be a decrease in risk, and many of the contractual incentives would lose their value (Silva *et al.*, 2003). According to Maia (2013), the level of asset specificity is connected to the cost and alternative use of these assets. In cases with high asset specificity, the greater are the risks of losses due to opportunism, and the greater should be the forms of transaction control (Azevedo, 2000; Ménard, 2004)

Specificity alone is not a sufficient condition to generate transaction costs. Its relevance gains contours in uncertain environments where the limits of rationality are highlighted. Under these conditions, every contract will be incomplete, because the managers do not fully predict the conditions to which the transactions will be subject (Dequech, 2001; Williamson, 2007). Azevedo (2000) complements the framework of arguments on the importance of asset specificity by clarifying that the greater the asset specificity, the greater tend to be the losses arising from an opportunistic action. This will bring, as a consequence, higher transaction costs to guarantee the protection against this type of behavior.

In their study with trading companies that perform grain storage, Barboza and Vidal (2014) found that one of the most important criteria is the choice of location for the implementation of a soybean storage structure. The group considered relevant the location and the transportation conditions of the region, also considering the freight price. Souza (2019) identified that "gaps between production volume and existing static capacity, inadequate transport flow through the storage network, and distances traveled between one unit that has a storage deficit to the other that has a storage surplus are all factors that incur increased costs."

According to Williamson (1985), the **locational specificity** refers to the geographic space necessary for the use of the asset, that is, there are locational restrictions for the use of certain assets. In the storage context, the cost of transportation to the warehouse, storage cost, and transportation cost between the warehouse and the destination, the port or agroindustry, are important variables. They directly affect the viability of the use of storage (La Cruz, Pizzolato & La Cruz, 2010; Péra, Rocha & Caixeta-Filho, 2016).

Gameiro (2003), Makiya, Peixoto, and Ferreira (2010), Ripoll (2010), and Soares and Caixeta Filho (1997) report the country's deficiency regarding the storage sector. In the months of March and April, peak harvest periods, there is a greater demand for transport services to take a large part of the production from regions far from the ports to its destination for export.

Due to the lack of warehouses, producers are forced to quickly dispose of the product immediately after harvest. Consequently, logistics is more compromised, at the mercy of the availability of transport service, and more expensive freights are charged in these periods of greater demand for transport service, causing a devaluation of the product, which is then sold at a lower price. Thus, the existence of silos and warehouses near the property could prevent such a situation during the off-season and provide the producer with greater profit.

According to Ballou, storage and transport costs account for roughly 12% to 40% of the agricultural sector's expenses. With this, it can be deduced that the economy or increase of expenses is directly proportional to warehouse location. Corroborating this idea, Souza (2019), emphasizes that gaps between production volume and existing static capacity, as well as the distances to be traveled between a unit that has a storage deficit to another that has a storage surplus, are factors that result in increased costs.

For Palhano (2015), it is important to analyze storage capacity in regions close to industries and production sites, because the greater the probability of displacement, the more specific the asset will be and the higher the transaction costs. To understand the importance of warehouse location, Figure 10 illustrates the path that grain production takes from the farm to its final destination.

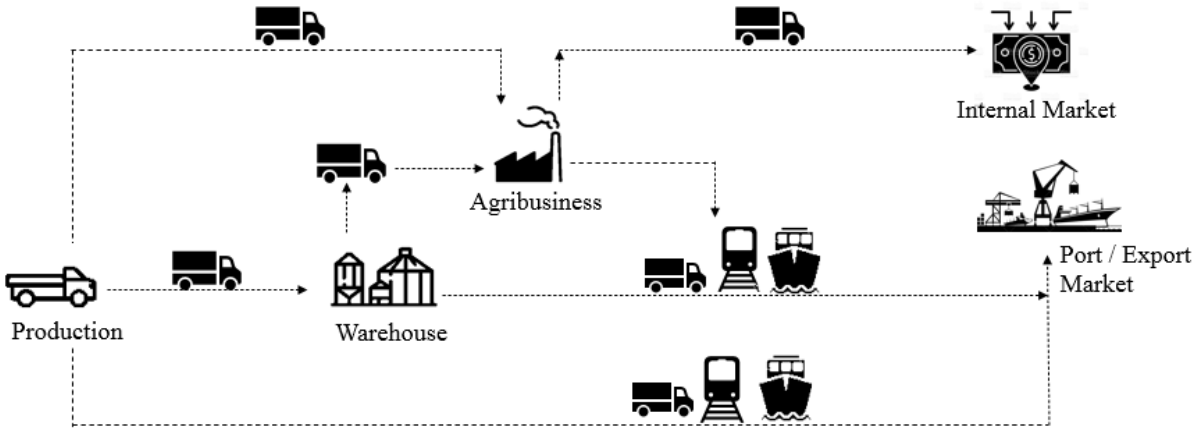


Figure 10 - Logistics of grain distribution in Brazil
Source: National Confederation of Transport (CNT), 2015

After harvesting on the farm, the grains follow two possible destinations. The first comprises the transport to the warehouse on the rural property or to public warehouses, cooperatives, or trading companies, carried out by road. The other flow includes the transportation from the warehouses, also by road, to the agribusiness, for processing. From there, the products derived from grains (oil and bran) are destined to the internal market by truck transport, or to the external market by road, rail, or waterway. For the cases in which the

grains will be exported in natura, the production goes from the warehouse directly to the ports, transported by highways, railroads, and waterways characterized by long distances, due to the concentration of production in areas far from the export ports (CNT, 2015).

According to research conducted by Ojima *et al.* (2008), soybean rail shipping terminals are supplied by trucks that shuttle between the producer's or company's warehouse and the rail terminal's warehouse. This proximity has high specificity, because the closer the warehouses are to the railroad, the more efficient the logistics will be. In the same way, it is necessary that the railroad unloading terminal be close to the export ports and to the warehouses of destination to supply the domestic market.

Soy is undoubtedly the one that most destabilizes the freight market, with the intense use of transport services, because the vehicles available become scarce and freight rates increase significantly (Caixeta-Filho, 2001). The concentration of the harvest season is a major problem that is intensified by the low storage capacity in most regions (Pontes; Carmo & Porto, 2009).

Physical specificity refers to the use limitation that certain assets have, either in the use of specific machinery and equipment for a given production process of a product to be traded (Wiliamson, 1985).

The production of soybean and corn crops is similar with respect to the use of machinery and can be shared and requires similar cultivation techniques. This allows soybeans and corn to be produced in the same region and in many cases in the same area at different times during the agricultural year (Mascarenhas, Nagai, Gallo, Pereira, and Tanaka, 1993). Soybeans and corn can also use the same drying and storage structure at different times of the harvest, thus reducing costs and making the installation of storage structures in agricultural frontier regions feasible (Maia *et al.*, 2013). Therefore, physical specificity should not be observed as a high-impact factor in the context of soybean storage.

From the data presented, it is possible to understand that the longer the producers decide to store their goods, the more they pay for them, due to the need for adjustments to the surcharge charged by CONAB for eventual occurrences of technical breakdown and adjustment of humidity losses, which will result in lower weight and consequently, lower payment received by the Company. Thus, time specificity is also a factor of great impact on the decision-making context of rural producers. This occurs because they will have to decide between selling their production in advance, in a probable scenario of less favorable prices, or choosing to leave the goods stored for a longer period of time and being charged for this over time.

Silva *et al.* (2013) broadly state that uncertainty in the theory of organizations can be understood as the degree of unpredictability of change and the degree of heterogeneity of the elements involved in the context that is due to dynamic features and a complex environment.

Agricultural products are exposed to several levels of uncertainty inherent to rural activities. They directly impact production and transaction costs, and profitability. Such uncertainties may relate to production (weather and crop problems), credit, and price (Waquil, Miele, & Schultz, 2010).

In his study on vertical integration in the soybean chain, Sologuren (2004) identified that transactions between industry/producers and originators/producers are marked by high uncertainties, since there are no long-term contracts signed between the parties.

Palhano (2015) reports in his research that during soybean purchase, "price is defined according to the state of the grain that arrives at the plant, regardless of the quality and how it left the farm. This scenario opens room for *ex-post* opportunism, which appears, primarily, as a result of market fluctuations, delayed shipment and/or payment, and divergence in product quality. And sometimes it results in contractual breaches by bran and oil producers or buyers".

There is an old saying that the agricultural property is an "open-air factory". This concept is used, both in the technical and scientific areas, to represent the uncertainty regarding climatic and biological factors of rural activity. Also in this context, farmers are price takers with relatively less market power between them and the agents with whom they do business.

Uncertainty is further aggravated because decisions about which production system to adopt in a crop year precede the moment when production will be available for commercialization. Therefore, these decisions are directly affected by costs and revenues. Between these two moments, market conditions can change substantially (Lima, 2019).

As previously mentioned, the destination of Brazilian soy production is both for the domestic and foreign markets. Both markets guide the demand for the oilseed. If the national and international stock supply increases, the price decreases, and producers tend to reduce the harvest. If the price rises due to reduced harvests, either due to a drop in Brazilian production or in the main competitor countries, producers tend to increase production. Thus, this is a cyclical commodity, and there is no permanent upward or downward trend (Contessa, 2020).

Soy is a commodity priced in the international market, with the Chicago Commodities Exchange as its main price indicator. This way, producers and companies have no control over their prices, and can only manage their costs (Kussano *et al.*, 2012).

According to Batalha and Silva (2001, p. 7), commercialization should not be understood as the simple sale of a given product. This is because the entire production chain is

involved in this process. Hence, it should be understood that the commercialization concept is broader and should incorporate the product's transmission through the different production stages.

From chart 8, exposed in the results section, it was understood that a governance structure is required to have simpler or more complex functioning mechanisms (via the market), depending on the level of interaction between the attributes. Similar to the scheme above, each of these attribute level combinations can be correlated to the complexity of decision-making.

According to Simon (1972), decisions are grouped into two categories: programmed (structured), which occur in a repeated, organized, and routine way; and the unprogrammed (unstructured), which, for not being planned and not occurring on a daily basis, demand more attention from decision makers.

Programmed decisions occur in low uncertainty environments and are relatively simple to make. On the other hand, unprogrammed decisions pose greater risks to the decision maker because they involve complex, often unknown situations in which most information is not available, making it more challenging for the actor to decide (Simon, 1972).

Complementing this view, Brilman (2000) concluded that decisions are made under conditions of certainty, risk, and uncertainty. When deciding under the condition of certainty, individuals are fully informed about the problem, the alternative solutions, and their respective outcomes, which in turn are measurable and unambiguous. Thus, decision-makers can anticipate (or control) events and their outcomes (Nogueira and Guerry, 2007). Deciding under such conditions is relatively simple, since it is limited to choosing the solution that presents the best expected outcome, thus being in the realm of programmed decisions (Neves, 2002).

Under uncertainty, individuals do not have the information needed to assign probabilities to the outcomes of alternative solutions, which often involve a series of small, interrelated decisions made over a period of time. Thus, they tend to be innovative and dynamic, and consequently unscheduled decisions. (Nogueira *et al.*, 2007).

As previously mentioned by Azevedo (2000), Ménard (2004), and Mondelli & Zylbersztajn (2008), the greater the asset specificity, the greater the opportunism of action tends to be, which raises transaction costs and the need for control. Consistent with this concept, Pohlmann, Aguiar, Bertolucci, and Martins (2004) state that assets with low specificity have low cost to negotiate, write, and guarantee the contract execution. If the asset is unspecific, complexity and uncertainty will be low. Without complexity and uncertainty, the negotiation and writing of contracts do not induce the bounded rationality of the agents.

From the above, it is possible to ponder that decision making among transactions follows the same logic based on the interaction of transaction attributes. This is because bounded rationality hinders economic transactions when uncertainty and complexity appear along with it. Given the certainty and simplicity of a transaction, decision making becomes less expensive (Williamson, 1981). Therefore, the complexity of the decision will also be lower. In complex environments, the decision-making process can become extremely costly, preventing agents from specifying in advance what should be done in each circumstance (Fiani, 2002).

Davis and Olson (1987) argue that the level of information is extremely important in decision making and may be influenced by the style and experience of decision makers. Thus, a decision maker's information may vary from perfect knowledge, passing through risk, to perfect uncertainty. The lower the uncertainty, the lower the risk inherent to the decision, and therefore less complex.

The uncertainty present in the relationships is mainly linked to the existence of opportunistic behavior that makes the identification of possible deviations in behavior and future commitments unpredictable and hinders the identification of false signals and information by those involved in the transaction (Pohlmann *et al.*, 2010).

Based on the ideas of the authors exposed above, an analytical structure was elaborated, through which it was possible to understand and analyze the level of complexity in the analysis of decision-making, from the governance structures adopted, based on the interaction of the attributes of the transactions (Chart 10).

		UNCERTAINTY				
		Low	***Medium***	***High***		
SPECIFICITY	***High***	Medium/High Complexity	High Complexity	High Complexity	***High***	**FREQUENCY**
	Medium	Medium/High Complexity	Medium/High Complexity	Medium/High Complexity	***Medium***	
	Low	Low Complexity	Low Complexity	Low Complexity	***Low***	

Chart 10. Decision complexity and combination of transaction attribute levels

Source: Prepared by the author (2021).

Starting from a transaction involving low specificity of the assets, low uncertainty regarding the required information for decision making, and low frequency. In this scenario, there will be a low level of information needed for decision making, due to low frequency, since, according to Zylberstajn (1995), occasional frequency does not allow the emergence of opportunistic behavior, since the parties are identifiable and wish the transaction to continue. Consequently, since there will be low uncertainty related to this type of transaction, it is proposed that the agents involved in such a decision use the assumptions of a programmed operational decision making, and therefore, of low complexity.

In the case of a transaction where the clarity of the information impacting the situation is highly uncertain, and where there is high asset specificity and high transaction frequency, increasing the chance of an opportunistic behavior, the decision scenario becomes less known, and therefore less trivial and scheduled it becomes, increasing its complexity.

In low specificity transactions, the condition of low complexity in decision making will be adopted, as it is already known that in situations with low specificity assets, the uncertainties that eventually exist tend to be overcome in a simple way and with low negative impact on decisions. For the situations presented in chart 8, it was observed that the most appropriate governance structure is the hybrid. Some interpretations on the complexity of decisions are possible; thus, within this structure, decisions can vary between medium and high complexity.

As demonstrated by Ménard (2004), the hybrid governance structure presents a certain diversity of arrangements for its operation (Figure 11). These arrangements can be based on trust agreements, with characteristics that are closer to market structures. They go through relationship networks, leadership relationships among agents until they reach a formal governance arrangement, which is the form closest to the hierarchical structure. The level of coordination within the range of possibilities of the existence of different hybrid forms (highlighted in the dotted lines in Figure 11) is defined by the level of uncertainty and opportunism that will arise between transactions.

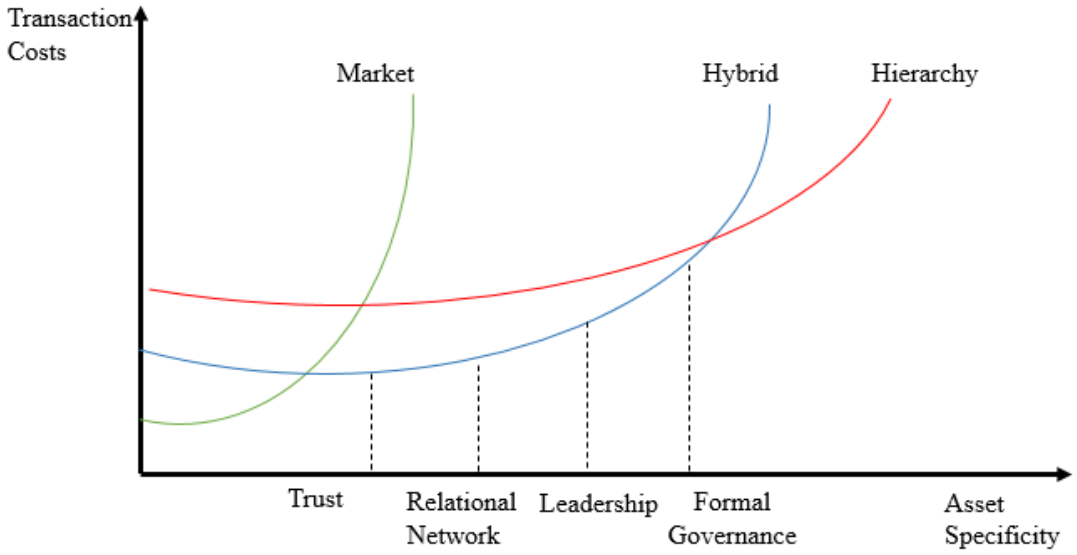


Figure 11. Typology of hybrid governance structures
Source: Ménard (2004).

Thus, just as the coordination level varies within hybrid structures, the level of simplicity in decision making will also vary. Therefore, we propose to define the complexity of decisions within this set of attributes as medium to high, thus being dependent on the appearance of opportunistic behavior and behavioral and environmental uncertainties. The closer to the market structure, the less complex the decision tends to be; conversely, the closer to the hierarchical structure, the more complex the decision making process is expected to be.

6 CONTRIBUTION TO PRACTICE

The present work hopes to contribute to rural producers and other agents involved in the soybean storage chain. Through the studies and analysis presented in this paper, it was possible to provide greater visibility to the impact caused by the problem of lack of storage space. Furthermore, it explicitly demonstrated how transaction costs, often not perceived by the agents, burden the chain. Because they are difficult to measure, transaction costs are often not considered when making decisions.

When relating the attributes with governance structures and later with the complexity of decisions, it was observed that the vertical integration model, represented here through the installation of a silo structure on the property, would bring some benefits aiming at the reduction of transaction costs and, consequently, the complexity of decisions. This is because, by producing, storing, and selling their own production, rural producers would be able to avoid the costs involved in negotiations and contractual obligations.

This study contributes to the decision of investing or not in a storage structure on the farm itself, conferring greater efficiency and competitiveness to the logistics of grain storage and transportation. It also contributes to disseminating the discussion related to the problems of grain storage logistics, given its enormous social importance, as well as the positive weight it has in the Brazilian trade balance (Lacerda-Filho, Silva, & Rezende, 2008; Péra *et al.*, 2016; Gaban *et al.*, 2017).

7 FINAL CONSIDERATIONS

The general objective of this dissertation was to analyze the effects of attributes on the complexity of decisions to be made in the soybean storage context. Based on documentary analysis and interviews with producers, it was possible to obtain the three specific objectives, and the confirmation of the four propositions related to the research constructs. From the analyses, it was possible to understand that transaction costs are consistently present in the soybean storage context and directly impact the level of complexity of decisions.

In this sense, the main contributions of this dissertation are related to the identification of the main factors that impact producers when selling and storing their production. In practical terms, the study allows reflections to be made on how much rural producers are burdened by depending on the market to carry out their storage and commercialization transactions.

The article also offers a better understanding of the impact of a storage structure on the transaction costs of a farm. Although it has a high initial investment in the medium and long term, it allows producers to obtain higher returns on their production, decrease their dependence on the market, and considerably reduce their losses due to the opportunism of storage agents. It was possible to analyze that there is a lack of studies that relate transaction costs to the decision-making process. As a suggestion for future research, the present study may serve as a basis for new investigations to be carried out in a practical way, through case studies, in which different governance structures are related through different forms of storage, relating them to different levels of complexity in decision making by the agents involved in each one of them.

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